

Compressed Air

Magazine



APRIL 1960

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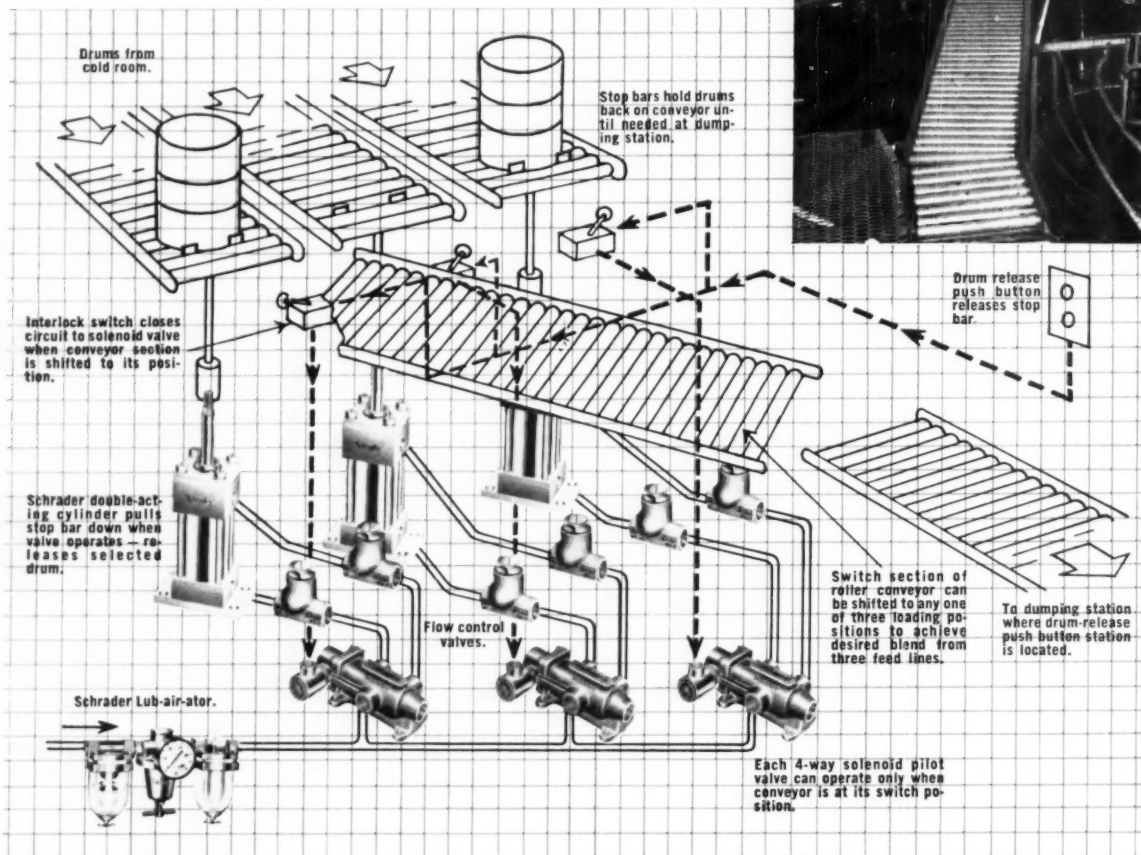
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PHILIPSBURG, N. J.

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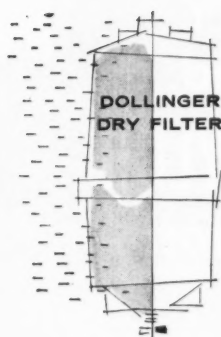
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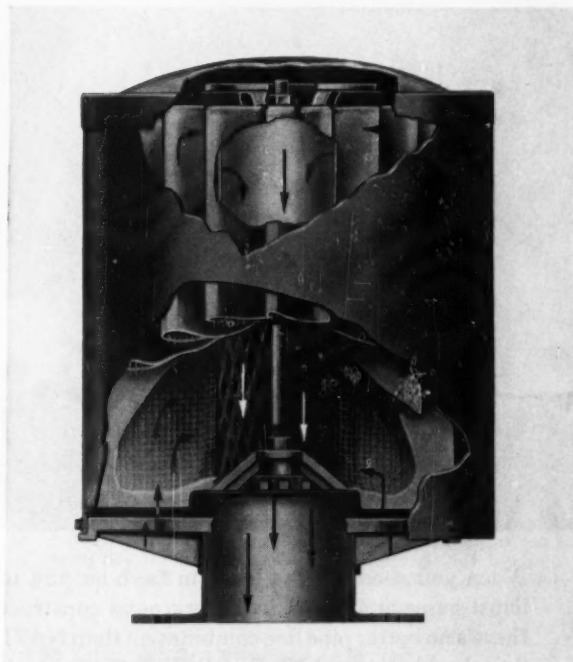


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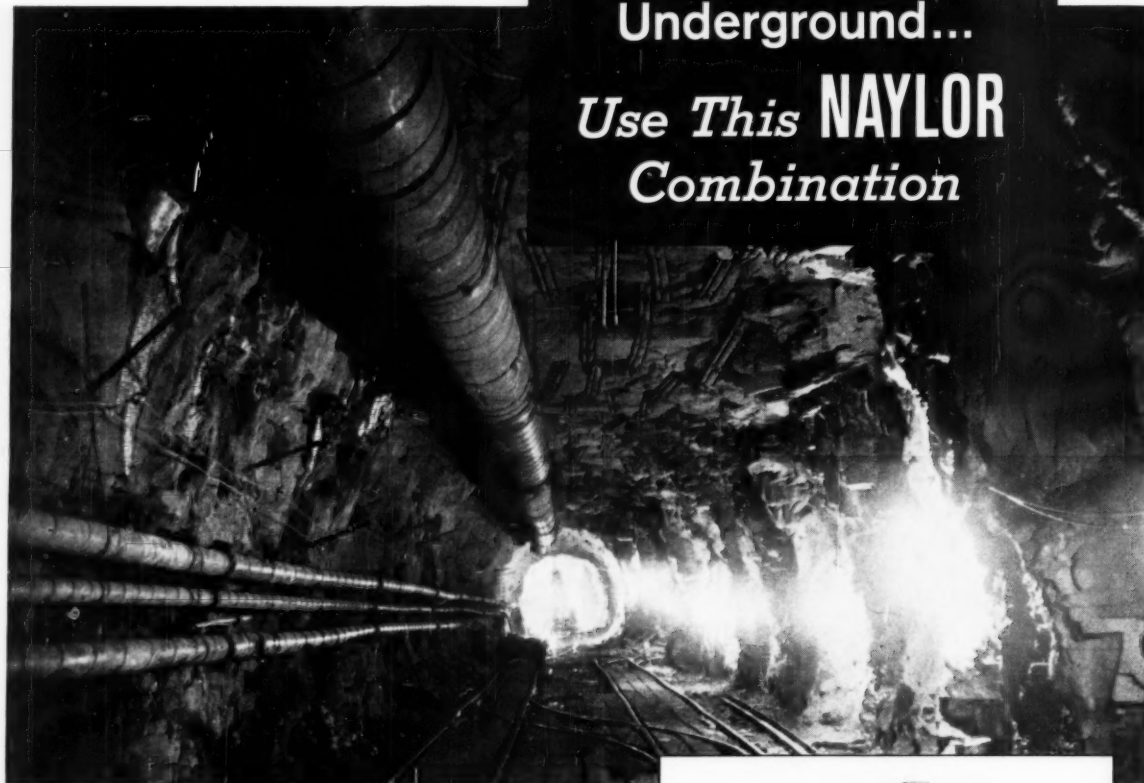


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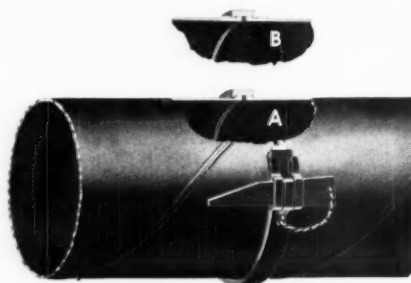
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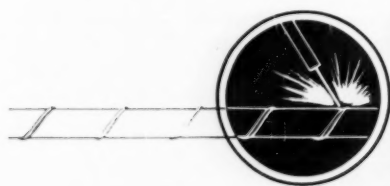
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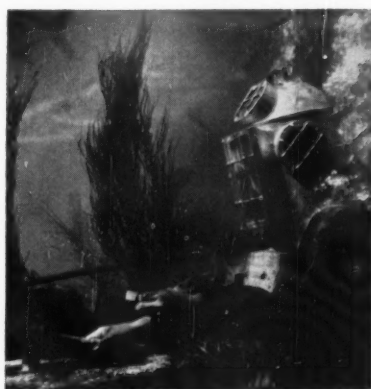
Compressed Air

MAGAZINE

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on the cover

A diver at Marine Studios, Fla., tacks down new sea fans to help give the tanks a natural appearance (see this month's feature, "Florida's Famous Aquatic Display"). Four men at the popular tourist site each spend about an hour and a half a day submerged, feeding the undersea creatures and maintaining the pools. Marineland's policy is to train young men for the underwater work and then promote them as better positions become available. Several of the key men in the organization started "at the bottom" in this manner.

14 Carving a Canyon Through Jugtown Mountain—G. R. Smith

Part of the Federal system of freeways, New Jersey's Interstate Route 78 will slice through a high hill called Jugtown Mountain. The project is the greatest single excavation in the history of the state's highway department and is probably the largest rock cut east of the Rockies.

18 Florida's Famous Aquatic Display—C. H. Vivian

Marine Studios started as an oceanarium where sea creatures could be conveniently photographed, but now has grown to be a must for tourists. Compressed air supplied to divers, who stay busy with feeding fish and maintenance, plays an important role in helping the show go on.

23 Common Denominator In Concrete Batching

Air power is a veritable Boswell to concrete batching equipment built by Noble Company. It is ever-present to perform five distinct tasks, in batchers varying in size from a small portable to one with 24-cubic-yard capacity.

26 These Tires Go Anywhere

Terra-Tires, wide flexible "feet" for vehicles, were introduced 6 years ago. They roll along on a variety of bizarre conveyances: peat harvesters, marsh buggies, and a Tree-Knocker that shakes down pecans, but doesn't crush the thin-shelled nuts underwheel.

34 More Gas Below Maracaibo

Creole Petroleum's Tia Juana No. 3 offshore station is busy forcing natural gas back into strata below the lake. Centrifugal compressors take the pressure to 2036 psia.

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A Husky "Monkey" Scales a Pole
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CELANESE CELLULUBES

used as air compressor lubricants step up safety in new missile submarines...

The advantages of Celanese Cellulubes were clearly apparent after a test program by Electric Boat Division. The tests included a study of lubricants dispersed in air under high pressure, followed by abrupt decompression. This results in a high-speed shock wave which can cause a violent explosion. Hydrocarbon lubricants proved highly vulnerable, but Cellulubes were so effective in resisting these extreme conditions that they will be used in all compressors in the new Polaris Fleet Ballistic Missile Submarines.

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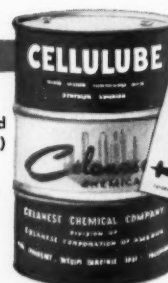
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over 3 years
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Versatility of the Gyro-Flo is illustrated above as four 600-cfm units are banked in parallel to provide reserve capacity low pressure air at 50 psi, throttled to 15 psi in the heading. Simple exhaust stack extensions were added to keep carbon monoxide out of the heading.

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★ 6 DAYS A WEEK

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This testimonial was given by Mr. Scara-villi, a man who knows contracting equipment from years of personal experience. He is a representative of Square Construction Co., a unit of the Mole Constructors tunnel contractor combine, Rankin, Pa.

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quarter of a million hours in almost continuous operation without a single forced shutdown is an almost unbelievable record. *Each* compressor has logged over 22,000 hours — equivalent to driving the family car 900,000 miles at an average speed of 40 miles an hour! It is significant, too, that this record applies not to a single compressor, but to *all twelve* Gyro-Flo units used on this big tunneling job.

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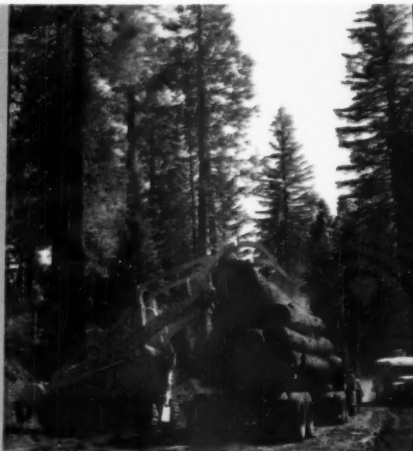
**The 100 H.P.
EIMCO 103**

**Tractor - Dozers
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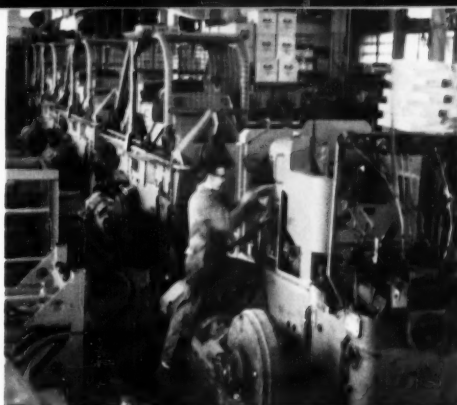


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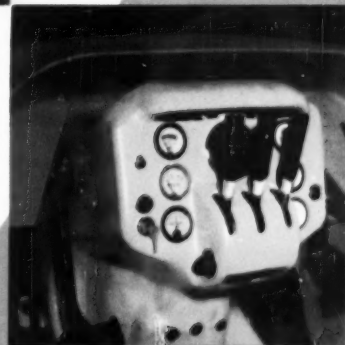
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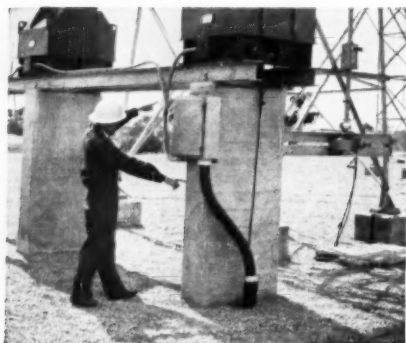


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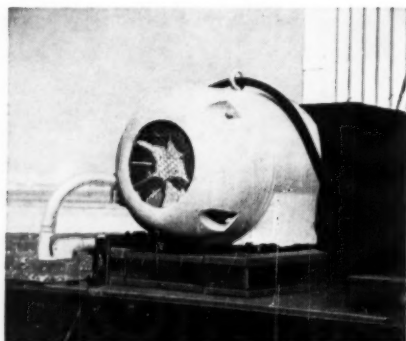
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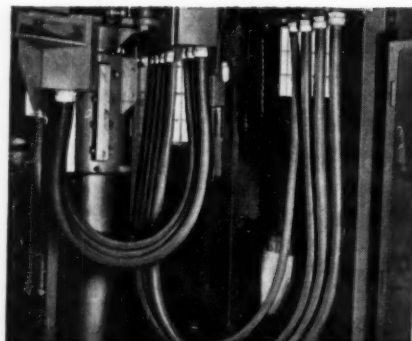
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TRADE SIZE	INSIDE DIAMETER		OUTSIDE DIAMETER		Appr. Inside Bend Diam. (Ins.)	Approx. Shipping Wgt. (Lbs.) Per Std. Carton	
	(Ins.)	Min.	Max.	Min.			Max.
3/8		.484	.504	.690	.710	6	60
1/2		.622	.642	.820	.840	7	70
3/4		.820	.840	1.030	1.050	10	70
1		1.041	1.066	1.290	1.315	12	90
1 1/4		1.380	1.410	1.630	1.660	15	70

TYPE E. F. † (Extra Flexible)—for machine tools and industrial equipment. (Meets J.I.C. requirements)

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	(Ins.)	Min.	Max.	Min.			Max.
3/8		.485	.505	.690	.710	4	60
1/2		.620	.640	.820	.840	5	60
3/4		.815	.835	1.030	1.050	5	70
1		1.030	1.055	1.290	1.315	7	60
1 1/4		1.370	1.395	1.635	1.660	8	80
1 1/2		1.575	1.600	1.875	1.900	11	55
2		2.020	2.045	2.350	2.375	14	75
2 1/2		2.480	2.505	2.850	2.875	19	105
3		3.070	3.100	3.470	3.500	23	80
4		4.000	4.040	4.460	4.500	27	105

Commercial tolerances apply on above figures.

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†Pat. applied for

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CUTAWAY SECTION of Type U. A. Seal-tite shows tough polyvinyl jacket over flexible galvanized steel core. Copper conductor wound spirally inside conduit gives positive ground.

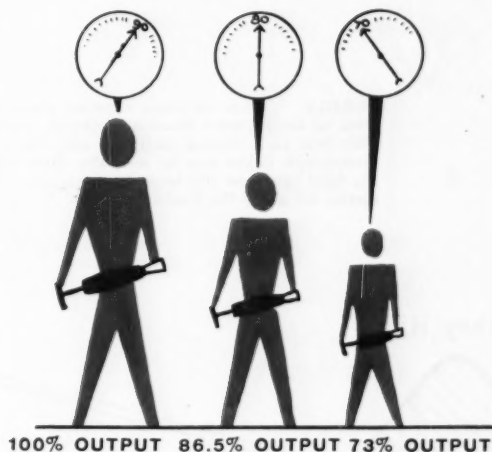
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Ingersoll-Rand Type 30
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½ through 20 hp

PROFILE This elevation drawing gives an idea of the work being done on the Jugtown Mountain project. Each horizontal inch represents 1000 feet; each vertical inch, 100 feet, for a distortion of 10:1. In the photograph below can be seen the three I-R Crawlmasters drilling on the final bench of the large Jugtown cut. To their right, a Payhauler carries fill from the Pattenburg cut.

Turkey Hill

4%

Fill

West Portal



LVRR
Tunnel

Carving a Canyon Through Jugtown

G. R. Smith

A GIGANTIC gulch of rock has been blasted out of western New Jersey's Jugtown Mountain as part of the work on a wide ribbon of concrete that will eventually reach completely across the state. The superhighway, Interstate Route 78, will begin at the Holland Tunnel. Its New Jersey portion will run to the Delaware River at Phillipsburg, N. J., the Pennsylvania state line. The highway is part of a planned network of 41,000 miles of Federal freeways.

Jugtown Mountain (hillside whisky stills reportedly inspired its name) is an 800-foot-plus promontory that rises up about 10 miles east of Phillipsburg to be one of the highest terrain features in the area. It is part of a formation of pre-Cambrian metamorphic crystalline rock, surrounded by softer sedimentary strata that have weathered to leave the harder stone as protruding ridges. When the surveys for Route 78 were staked out across the state, the line fell directly on Jugtown Mountain.

The contract that includes blasting through the high hill, provides for some 5 miles of road to link an existing new portion of Route 78 with an older 4-lane highway called Route 22. A short 2-lane section of Route 22 leading up to Jugtown Mountain will be eliminated. Awarded to Yonkers Construction Com-

pany, Yonkers, N. Y., the \$6,379,960 parcel specifies bringing the road up to subgrade. A separate contract will be let for the surfacing. Because the freeways—90 percent of which are paid by Federal funds—allow nothing steeper than 4 percent grades, plenty of rock has to be moved on this job. In fact, the contract is the largest single excavation project in the New Jersey Highway Department's history, and is thought to be the largest highway rock cut east of the Rocky Mountains. About 3,600,000 cubic yards must be taken out. Eighty percent of this is rock.

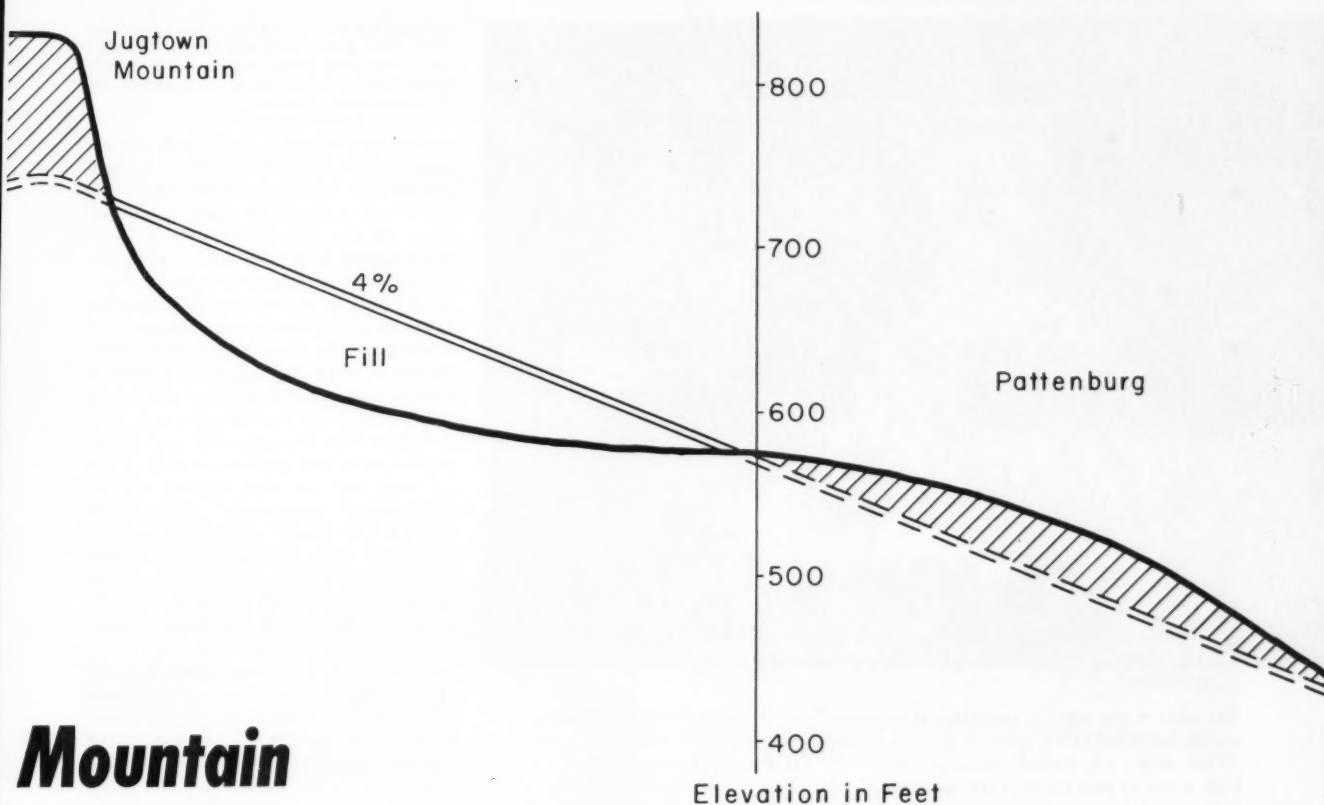
Actually the contract consists of three cuts (see profile drawing). In the middle is the large Jugtown Mountain one. To the west is the second major rock job, through a smaller feature colorfully named Turkey Hill. To the east is Pattenburg cut, containing some rock but much more earth than the other two. A factor complicating the project is that an existing tunnel of the Lehigh Valley Railroad passes through Jugtown Mountain below the highway's finished level.

The contractor first moved to the site on December 15, 1958. Initial work started on January 17, 1959 and concentrated efforts got underway on April 6. The contractor is presently about 80 percent complete. He has expended only about 250 of the 440 working days

allowed in the contract, and expects to finish the project in July of this year.

After stripping was completed last spring, drilling and blasting began on the large Jugtown incision. Most of the heavy drilling of the 20-foot benches in the deep cut has been done with three





husky Ingersoll-Rand Crawlmasters equipped with I-R's new D525 Drifter capable of drilling 4-, 4 $\frac{1}{2}$ - and 5-inch holes. It is the maiden job for the newly developed Crawlmasters. The unit is a track-mounted self-propelled rig that is designed as the midway size between two

other Ingersoll-Rand machines, the smaller Crawl-IR and the larger Drillmaster. Besides working vertically, the Crawlmaster's high tower can be tilted with hydraulic cylinders for off-vertical drilling at any angle—to 15 degrees above horizontal. As well as drifters, it also

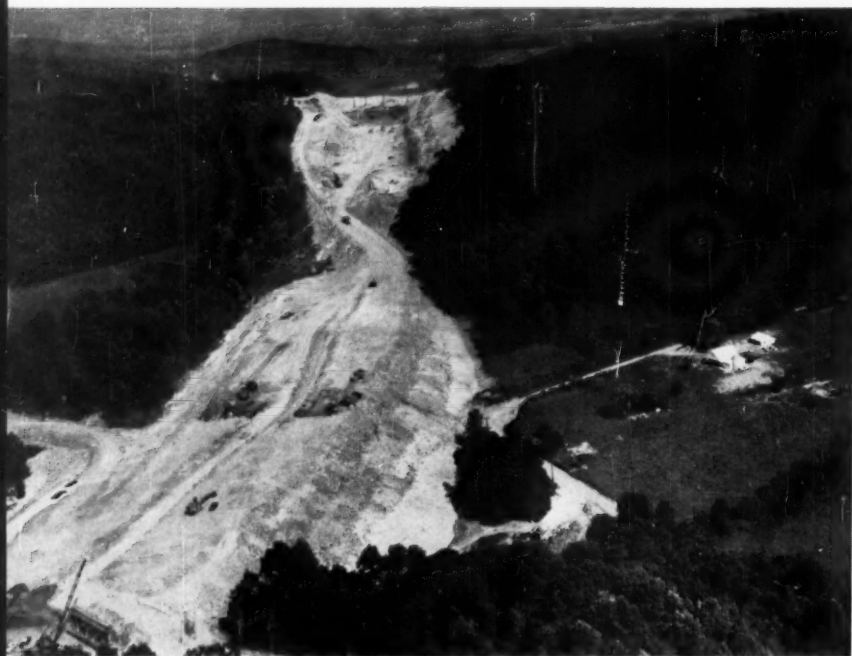
can be equipped with out-of-the-hole and down-the-hole drills to put down blast holes of 4- to 6 $\frac{1}{2}$ -inch diameter. The new I-R units have averaged about 280 feet of 4-inch hole per day on the Jugtown project. They drill to a 23- to 24-foot depth, and according to the contractor have given an excellent account of themselves on the job.

Smaller drilling tasks are carried out by seven Ingersoll-Rand Crawl-IR's that put down holes along the sides of the cuts and similar places where accessibility is limited. They have averaged about 45 feet an hour of 3-inch hole. The Crawl-IR is a highly maneuverable tracked drill with complete hydraulic controls for its boom.

Six benches are being taken out of Jugtown Mountain to carve the canyon. In all, this major excavation will produce 1,270,000 cubic yards of rock. The cut is more than $\frac{3}{8}$ of a mile in length, 117 feet deep at its deepest point and 140 feet wide at the bottom, the roadway width. It flares out to a 450-foot-width at the top.

Turkey Hill cut goes down about 50 feet at its deepest point and covers a horizontal distance of more than 1000 feet. Most of the material from the two cuts has been moved to a large fill between the two. Nearly 600 feet wide at the base, this fill is 127 feet high and 142





AERIAL VIEW Looking east, this picture taken during the early fall shows the large fill in the foreground and one of the early benches being taken out of the Jugtown cut at background, center.

feet wide at the top. It contains an estimated 1,200,000 cubic yards of material. (Two large egg-shaped culverts allow high water to pass through the structure; these contain about 5800 cubic yards of reinforced concrete.) To move such a large amount of fill demands a large daily haul. The average during the summer and fall of 1959 was about 12,000 cubic yards daily. On the best day 22,000 cubic yards of rock was wrestled from the mountain.

Compressed air that sends the rock drills into the hard rock and provides motive power for both the Crawlmasters and Crawl-IR drills comes from thirteen Ingersoll-Rand portable rotary compressors, twelve Gyro-Flo 600's and one 900-cfm machine. Normally, five of the 600 units and the 900 are aligned as a battery and connected to a common pipe to feed the large drills. The remaining seven 600's are towed by the Crawl-IR machines.

Hard rock work is a specialty of Yonkers and on this job the contractor hasn't been disappointed. The cuts mainly encounter gneiss of various conditions with a few strata of interbedded quartz. The gneiss varies from softer decomposed material near the surface, to a fractured type farther down, to a solid, very hard type at the lowest elevations.

Once the holes have been put down into the hard rock, blasting proceeds with several makes of explosive—Du Pont, Hercules, Atlas and American Cyanamid. Forty-percent ammonia dynamite is used with Atlas primers placed at the bottom. Delays aid complete breakage. When asked for specific in-

formation about blasting techniques at the job, Project Manager Arthur E. (Red) Ellison explained that several new ideas had been tested, although equipment and explosives were conventional. The innovations have produced a sizably larger amount of loose rock than is normal in such blasting. For this reason he said that, understandably, he is hesi-

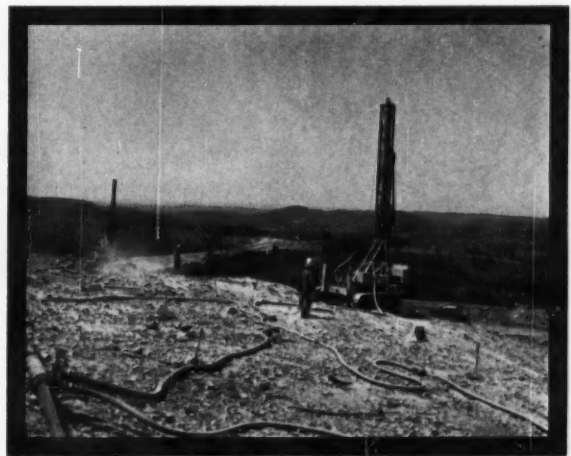
WORKSITE Five Gyro-Flo 600's and one 900 feed air through 6-inch-diameter Naylor pipe to the Crawlmaster drills here. At far right a Bucyrus-Erie 88-B (see next page) loads two Euclids. Along the opposite bank of the cut, streams of water running out of the gneiss have frozen as tall columns. This picture was taken from the original elevation of the north bank.



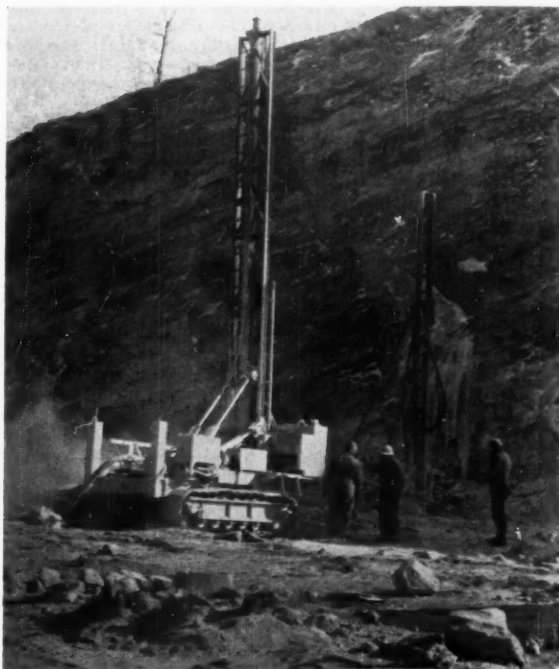
tant to give details. The visible results produced on the project tend to confirm the project manager's statement about the effectiveness of his blasting innovations. In any event, more than 750 tons of explosives have been used. The contractor's own seismic crew takes readings of all blasts to be sure that the explosion intensities fall within the limits prescribed by the New Jersey state code. Nearly all of the blasting work is finished though some earthmoving is still to be completed on the Pattenburg cut.

A large fleet of equipment and a completely equipped maintenance shop are on hand with the rock drilling and air compressing equipment. Two 88-B Bucyrus-Erie shovels with 5-yard buckets and three 80-B Northwest shovels with 21½-yard capacity are used. They load to fifteen International Harvester 21-yard Payhaulers and ten 30-yard belly-dump Euclids. At the Pattenburg cut, much work has been done with six Euclid scrapers that receive an added push from International TD-24 dozers. Ten of these are on the site. Along with a D-9 Cat, they have kept the cut slopes in constant finish—a Yonkers' policy. Yonkers, owned by Edward J. Petrillo, purchased most of the machinery new for the contract. Some of the machines at this job are also used at another contract he is working at Bound Brook, N. J.

Two Seasons at Jugtown



SUMMER Powered by I-R Gyro-Flo 600 compressors, three Crawl-IR's put down blast holes during the summer of 1959. The picture above shows Yonkers Construction Company's efficient maintenance shop atop Jugtown Mountain.



WINTER A Bucyrus-Erie 88-B loads rock into a Euclid as work continued through the cold March of 1960. At left a Crawlmaster works in the hard gneiss as a chill wind shunts down the man-made canyon.





Florida's Famous Aquatic Display

C. H. Vivian

FEW of Florida's numerous tourist attractions are as popular as the aquatic show presented by Marine Studios, located between St. Augustine and Daytona Beach, on the East Coast. This rare blend of education and entertainment is given six times daily, starting at 9:30 a.m., to accommodate the crowds that come. Ninety percent of the spectators are visitors to Florida.

Nowhere else can so many creatures of the sea be seen in simulated natural surroundings. Two large display tanks provide excellent facilities for underwater viewing and photography. One contains ten porpoises, the mammal noted for its playfulness. The second holds fishes and other ocean dwellers of many kinds and sizes, ranging from sharks and barracuda to tiny, bright-hued tropical species.

To start the entertainment, the remarkable porpoises, which seem to have powerful springs in their lithe bodies, leap straight out of the water with little apparent effort to take fish from the hand of an attendant. Next, a diver descends into one tank and then the other to feed the occupants. Finally, the scene shifts to a performance tank. Here the ever-surprising porpoises bow, "sing" by whistling through their blow holes, jump through hoops and over hurdles, extin-

guish a fire, play baseball, football and basketball, uncork an amazing leap of 16 feet above the water to pull a sleeve from the end of a bar, and otherwise show their agility, speed, co-ordination and keen perception.

The originators of Marine Studios reportedly got the idea in Africa, where an expedition bent on photographing wild animals had difficulty getting close to them. The problem was solved by constructing a huge corral, with mile-long sides. The animals were herded into the enclosure and photographed from vantage points along the stockade walls.

The success there led to pondering the possibility of doing something similar with creatures of the sea. As it was not feasible to build suitable structures in the ocean, it was decided to erect them on the shore where sea water was close at hand. For a number of reasons, a warm climate was preferred and this led to the choice of a Florida location. A tract of virgin land about 50 miles south of Jacksonville was purchased and developed. The community was incorporated and has its own civic officials. No effort was made to make it a residential area, however. Only half a dozen persons live there and most of the others of the 80 that run Marine Studios make

MARINELAND In the left foreground a porpoise show is in progress. Six daily performances draw an average attendance of 1000. Back of the bleachers is the rectangular fish display tank, and farther on, the circular porpoise display tank, with a flume between. At left center are the water pumping station and filter beds. The Atlantic surf rolls in at the top and Highway A1A is at bottom.

their homes in St. Augustine, 18 miles to the north. Cornelius V. Whitney of New York and a group of friends financed the undertaking and still own it. Douglas Burden, Whitney's brother-in-law, is president. He lives in Vermont.

Two Tanks

As the name Marine Studios indicates, the original purpose was to collect and photograph aquatic creatures. Two concrete tanks were built, connected by a flume for transferring specimens from one to the other. The porpoise tank is circular, 75 feet in diameter and 12 feet deep and holds 400,000 gallons of water. The second tank is rectangular, 100 feet long, 40 feet wide, 18 feet deep in the central portion and has a capacity of 450,000 gallons. It is termed an ocea-

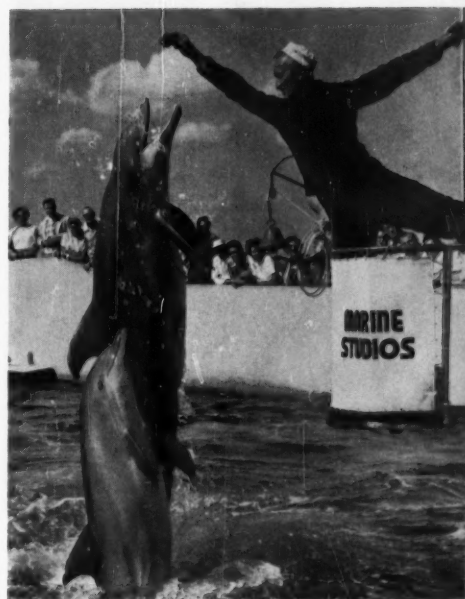
narium—a place where many different varieties of fishes live together, much as they do in nature. In an aquarium, the different species are separated. Marineland had the world's first modern oceanarium, although the Romans may have had them 2000 years ago. Marcus Terentius Varro wrote of large, salt-water fish ponds maintained by the nobility, "not for profit, but to be seen and enjoyed." Some had aqueducts leading from the sea directly through the mountains to insure the survival of the animals kept in the pools. Some had reflective bottoms to display the fishes more readily.

Up to 7 million gallons of water is pumped daily at Marineland by three motor-driven centrifugal pumps that can together handle 5000 gpm. The offshore intake is a perforated pipe buried in the sandy bottom so as to filter the

MESS CALL Tenants of one of the large tanks greet a diver during one of the six daily underwater feedings. These are viewed through portholes at different elevations in the tanks. The basket contains chopped up fish—mainly mullet. Adequate feeding curbs the instinct of larger fishes to devour smaller ones.



JUMPING One of ten porpoises in the circular tank leaps from the water to take food from an attendant's hand. The animal will then turn and descend head first into the pool, avoiding its companions.



water. Adjacent to the pumping station is also a conventional filter bed that can be used when needed. (An outdoor tank designed for underwater viewing failed in Maine a few years ago because the water was cloudy and vision was restricted to a few feet.) As the rectangular tank contains tropical fishes, its water temperature is not allowed to drop below 68° F. In winter time this involves heating the water by circulating it through one or more of five oil-fired heat-transfer units.

The tanks are open at the top to provide natural underwater illumination for observers in the corridors that surround them. Some 200 portholes or windows give clear vision from all angles. The tanks were stocked with aquatic specimens and opened to public display in 1938. During the remainder of the year, 30,000 scientists, photographers and curious visitors thronged the area, and it

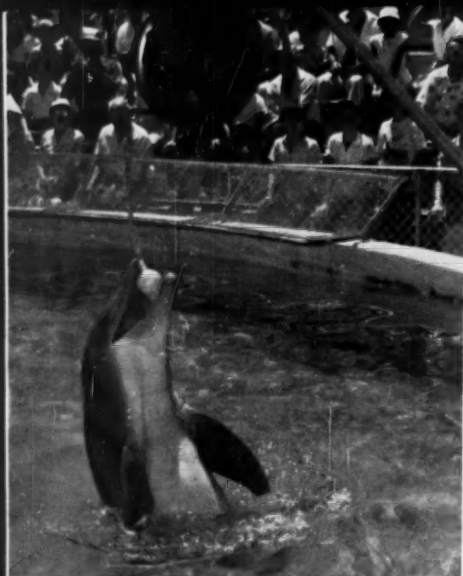
was plain that the project had captured the public's interest.

Ways to widen its appeal were sought. When the show was reopened in 1946 following a wartime interruption, the possibilities of training porpoises intrigued the staff. The brain of these mammals is larger than Man's and the animal exhibited an aptitude for learning that gave good promise. Moreover, its quizzical, smiling facial expression, its playful antics, sleek streamlined body and other attributes stamped it as a born showman.

Privately and without publicity, experimental training was started under the guidance of a leading authority on animal behavior (porpoises had not been trained previously, so no one with experience in that line was available). The results exceeded all expectations, and in 1954 the show was "put on the road." A tank 100 feet long, 40 feet wide and flanked by bleachers seating 1000 was built and ever since these fascinating performers have captivated audiences with their remarkable athletic feats and other exhibitions, all done in response to commands, given either by signal or voice.

Food For Thought

There is a direct relationship between performing and feeding. After completing each act successfully, the porpoise is given a piece of fish. The promise of this reward makes him a good actor. This relationship is also evident during the underwater feeding periods in the circular tank. The porpoises stay close to the diver while he is handing out fish, nuzzling him with affection, but desert him as soon as the last morsel of food



is gone. Care must be taken not to overfeed a performing porpoise lest he lose interest in the routine.

Porpoises are inherently friendly to humans. They have 90 teeth apiece but won't close them on a hand held in the mouth. Some are more amiable than others and immediately recognize people they like. Take the case of Pudgy, largest of the group in the circular tank—500 pounds and 9 feet long. She likes Ernest Libby, Marineland photographer who often descends into the tank to take pictures. Pudgy nudged him one day and he responded by scratching her back. Every time he enters the tank now, she is at his side within a few seconds.

Porpoises like to have their backs scratched as well as cats do. Biologists have noted a continual sloughing off of the outer layer of skin and this perhaps produces a sensation akin to itching. In captivity they scratch themselves on anything available. As sharp objects might injure them, large brushes are attached face up to rocks in the tank bottom and the creatures use them frequently.

Not all porpoises can be trained, either because they are not as bright as their fellows or else they just don't care to make the effort. A notable example was Priscilla who lay on the bottom most of the time and wouldn't join the others in their stunts. Eventually she was "flunked out" of the training school, both figuratively and literally. She was put back into the ocean, but apparently stayed in the neighborhood and one day she was caught for the second time. Nobody knew it at first, but they did when she sulked and balked as before. After she had turned down a second chance to acquire an education she was rejected again—a confirmed delinquent.

It required about 3 years to train the first porpoises, but after that it came easier. Like college students, these animals can "cram" knowledge into their



PRECOCIOUS PORPOISES From the time the clanging of a gong opens the porpoise "school," the likeable animals perform one amazing feat after another (left to right). They "sing" through the breathing blow hole in the top of the head. Throw-

heads quickly if it becomes necessary. A few years back one named Elgie, a star of the show, swallowed an inflated ball and died when efforts were made to remove it from his stomach. A replacement was needed immediately and a youngster called Flippy was the logical choice but wasn't quite ready for the "big time." However, he came through nobly under pressure, in the best tradition of show business. He had never jumped higher than 13 feet, but in a short time was doing the regulation 16 feet. To guard against a recurrence of this sort of thing, there are five members of the educated group now: Flippy, Nellie, Jack, Splash and Sinbad. All take their turns as performers, two being used on each show.

The success attained with porpoises perhaps portends the future introduction of other aquatic acts. Two whales that were flown from California in the summer of 1959 are harbored in a retaining tank adjacent to the porpoise performing pool and a start has been made toward educating them. No announcement of their progress has been made but as whales are of the same family as porpoises, perhaps they will be surprise performers of another year.

Meanwhile, although Marine Studios has become a bit more theatrical, it has lost none of its original dignity as a scientific institution. It is still a place where marine life is studied seriously. It maintains splendid research facilities in a building devoted exclusively to that purpose. Its curator and staff of ichthyologists and aquarists co-operate in numerous ways with other scientists to investigate and photograph King Neptune's realm.

Dolphin Sonar

During World War II, Naval underwater listening stations repeatedly picked up sounds that were not understood and this led to research to determine their source. Recent investigations have shown that the bottle-nose dolphin, or

porpoise, navigates with the aid of the echoes of sounds it emits, displaying something akin to the bat's radar-like power (or submarines' sonar). Marine-land collectors noted several years ago that the porpoise could detect not only submerged objects but also holes in nets, even on dark nights or in turbid water of low visibility. Study by Dr. W. N. Kellogg, of Florida State University, showed that dolphins emit bursts of noise of very high frequency. If the sounds are returned by echoing, the animal's sensitive hearing apparatus picks it up (sound travels much faster in water than in air). It was proved that dolphins were able to distinguish between two different sizes of food fish merely by "scanning" them with short bursts of sound. Other tests showed that they could easily avoid numerous obstacles suspended in the pool. It is assumed that other members of the cetacean family share this ability, as they have similar organs of hearing. It is also known that a great variety of fishes and shrimps emit noises and that the old conception of the "silent sea" is false.

Most of Marineland's specimens are found in nearby waters and it does its own collecting, using a specially designed 46-foot trawler, the *Porpoise III*. To keep specimens in good condition during the homeward journey, it has an 11×14-foot tank in the forward section through which sea water is circulated. The boat ranges as far as the Gulf Stream, 45 miles offshore.

Various fishing methods are used. In many instances the conventional hook and line suffices. Specimens caught that way are not normally hurt beyond a superficial mouth puncture that soon heals. The line used for catching sharks is several hundred feet long, with hooks attached every 30 feet by short chains. With the hooks baited, the line is anchored at each end, marked by buoys and left for several hours. When the collectors return, one or more sharks are usually found hooked. By the time the line has been retrieved, the quarry is



ing a basketball and catching a football with the snout seem to come easily to porpoises. Most remarkable, however, is an incredible leap of 16 feet into the air—approximately twice the animal's length.

usually exhausted and can be taken aboard. Some other species that do not take natural or artificial lures are netted. Various types of ray are captured with a net of 20-inch mesh.

Special gear is utilized to catch the porpoise, reputed to be the fastest thing that swims. They are too elusive to be caught, were it not for a strong sense of curiosity and playfulness. Almost invariably they investigate a boat and cavort in its bow wave. There a snare of ingenious design can be slipped over the tail. As the tail must be moved freely in swimming, pulling on the rope slows the porpoise and it can be hoisted to the deck without great difficulty. Once there, it lies quietly and does not attempt to flip overboard. It must, however, be kept in the shade and its skin moistened periodically to prevent sunburn and drying.

During summer months the *Porpoise III* tries for game fish. Many varieties, such as tarpon, barracuda, jacks, cobia, etc., are caught and successfully transferred to captivity. Some others—sailfish, marlin and swordfish for example—do not make the shift readily. For one thing, they resist capture with all the strength they have and by the time they reach Marineland, they are exhausted. Also, it seems that they exhibit something akin to claustrophobia. They can't stand being penned up. Even sharks have to be "walked" by a diver in the flume when they first arrive. Otherwise, they often lie still and would die for lack of oxygen were the flow of water across the gills not restored by keeping them moving.

Flying Fish

Incidentally, airplanes and plastic bags have lessened the problem of transporting shipments of small fishes. Some water is placed in the bag and the remaining space is filled with oxygen, and the container sealed. As the oxygen in the water is depleted, more is absorbed from the overhead supply. Aboard a plane,

truck or train, there is enough movement of the water to aid this transfer.

In addition to its usual sources of supply, Marineland encourages local fishermen to bring in odd-looking specimens they may catch. Those that are presented are generally familiar to the curator, but some substantial payments have been made for rare types. Specimens must, of course, be in a condition to have a reasonable chance of survival in captivity.

Tropical fishes are purchased from a professional collector, who ranges through the Florida Keys and even to the Bahamas. His base is Fort Lauderdale and Marineland sends its specially equipped truck there to get the specimens. It has a water circulating and aerating system that supplies the required oxygen and the specimens make the 300-mile trip with negligible losses.

Tank inmates of diversified sizes and temperaments get along well together despite the natural habit of large ones to eat smaller ones. They don't suddenly acquire this live-and-let-live policy when they become captives. The plain truth is that they are kept so well fed that they rarely revert to primitive instincts. Once in a while, attendants admit, a small fish or two disappear, but this invariably happens at night and nobody can say for sure whether one of the larger denizens had a midnight snack.

Some of the smaller varieties have a better chance of surviving there than in the open ocean. If chased by something bigger, they can dart into the protection of a small "shipwreck," a 7-ton coral reef or other structures that are strewn along the tank bottom. Some fishes—the gray or mangrove snapper is one—actually increase in numbers and must be thinned out occasionally.

An important part of the natatorial show is the underwater feeding. The divers that do this wear conventional diving clothing surmounted by an aluminum helmet of the type used in shallow water. Unlike the headpiece for deeper work, it is not firmly attached to

the suit at the neck. Instead, it is merely lowered over the head and rests on the shoulders. Compressed air for breathing is fed to it at the top through a hose. The air also prevents water, which enters the helmet at the bottom, from reaching the mouth and nose.

In addition to descending for the feeding stints, each diver is responsible for a certain amount of tank cleaning. The double-glass windows of the observation port holes are cleaned daily on the inside to remove algae and other deposits that would otherwise reduce their transparency. There are four divers and each spends approximately 11½ hours of his working day underwater.

Air Supply

The compressed air was formerly supplied by a vertical, air-cooled, automotive-type compressor that discharged at around 150-psig pressure. It ran at high speed and delivered air that was so hot that it was still uncomfortably warm when it reached the divers, despite the efforts to overcome this by passing it through an aftercooler. The heat was especially bothersome in summer. The cylinders of this compressor were lubricated with oil and, even though this was sparingly used, a certain amount of it got past the wiping rings on the pistons and was carried along in the air stream and into the divers' helmets. The combination of warmth and oil vapor was at times very unpleasant and occasionally caused a diver to become ill. Various kinds of oil were tried but none was found that was not offensive. Likewise, several attempts were made without success to remove the oil vapor by filtering the compressed air.

The troubles were eliminated in 1952 by installing a compressor that requires no cylinder lubrication because the rings are faced with a graphitic material. It



is an Ingersoll-Rand Class ER-NL (non-lubricated) machine. It is of different construction than the older unit, being horizontal instead of vertical, water-cooled instead of air-cooled and of single-stage design rather than 2-stage. Instead of discharging at 150-psig pressure, its maximum is approximately 35 psig. Driven through vee-belts by a Diehl 5-hp motor, it runs at a conservative speed. The relatively low discharge pressure and

operating speed both tend to reduce the generation of heat. The same aftercooling equipment as existed for the older compressor is used. In addition, intake air is taken from outside the building, which was not formerly the case.

At no time now does the temperature of the air reaching the divers exceed 70° F and, as no lubricant is used in the cylinder, no oil vapor can get into the air stream. As a result, the divers work

AIR OUTLET Dave Nelson, one of four divers, emerges from a tank and hangs his helmet on a metal arm. The hose that supplies him with air is played out from the reel at left. On the rear side of the reel is a pressure regulator and an air gauge. Most of the newer divers set the gauge at 20 psig; older ones prefer 12-14 psig.



DIVERS' DUTIES In addition to feeding the occupants of the tanks, Marineland divers handle several house-keeping chores that help keep them underwater about 1½ hours a day. Here one vacuums coquina sand (a limestone of crushed shells) from a tank bottom before adding fresh.

in comparative comfort and without fear of illness from poor air.

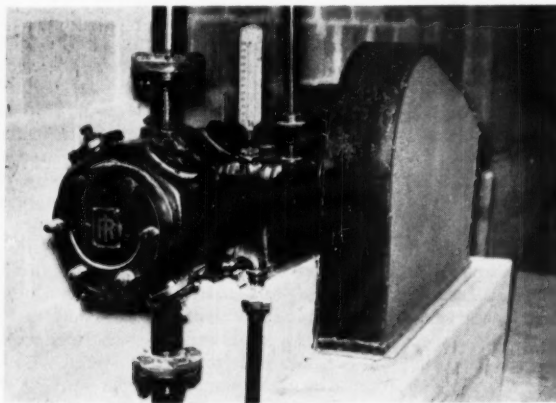
The new compressor now carries the load, with the older one in reserve. If the operation of the regular unit is interrupted for any reason, the resulting drop in the line pressure serves to activate the older machine, which then maintains the air supply until the Class ER is returned to service.

In addition to serving the divers, air is piped to all of the various wall tanks where small specimens are displayed in the corridors. These are normally aerated by streams of water, but air lines are provided for use in case the water pumping system fails.

Other air lines run into small basement tanks behind the scenes where various small creatures are photographed and their life habits studied. Staff Photographer Libby has arranged special facilities there that give photographs all the realism of natural settings, even to Pacific coral reefs. With these "props," he can get almost any effect wanted for pictures made to accompany scientific or popular articles that may be prepared by Marine Studios staff members or others. There he made the pictures to illustrate his own article on skates that appeared in *National Geographic Magazine* last year.

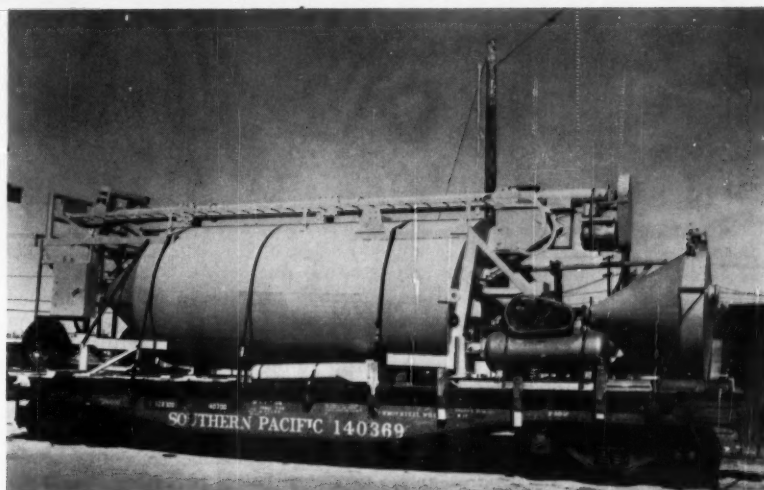
In one tank, Libby makes identification photographs in color of each new type of small fishes brought in. The specimen is immobilized by holding it lightly between two panes of glass slid into slots in the sides of the tank.

UNTAINTED AIR This is the Ingersoll-Rand "nonlubricated" compressor that delivers oil-free compressed air to the divers. The Class ER, 5x4-inch, single-stage unit has automatic control to shut it down when the receiver pressure reaches 36 psig and start it when the pressure falls to 31 psig.





BATCH-A-BOUT Ready for shipment (below) from the Noble factory, this cement batching assembly is shown with its Ingersoll-Rand, 2-stage, receiver-mounted Type 30 air compressor. The 5-hp unit is standard; in semi-automatic plants, a 3-hp compressor is adequate. In action (left), both aggregate and cement batching are controlled by air rams.



AIR P O W E R

Common Denominator in Concrete Batching Plants

CONSTRUCTION of Glen Canyon Dam in Arizona; rocket test stands at Cape Canaveral, Fla; and curbs and gutters, anywhere: all require cement and batching plants of some sort or another. The plants may vary considerably in size, yet they all make use of one common commodity—compressed air.

Noble Company, well-known Oakland, Calif., maker of concrete batchers, as well as conveyors, bins, scales, etc., manufactures just such a broad line of equipment for use by contractors, government agencies, ready-mix companies, aggregates producers, and building supply firms throughout the United States. Every batching plant assembly incorpo-

rates a heavy-duty compressor to provide the required air power—the air performs five distinct functions. *First*, it activates clam shell gates at the bottom of aggregate bins; rams, which in turn move louvers at the end of cement screw feeder systems; discharge gates under the cement and aggregate batchers; 2-way selector gates beneath weight batchers (the means by which flow of materials can be directed into one or the other of two mixers); 2-position gathering hoppers; and reclaiming tunnel gates under the aggregate ground storage silos.

The *second* function of compressed air is to activate vibrators on the aggregate batchers and on overhead storage bins. This keeps sand and gravel flowing and

production running smoothly. It is aided further by the *third* use—low-pressure, high-volume air, injected along the inside walls of the cement storage silos to fluff the cement so that it will flow evenly into the feed system.

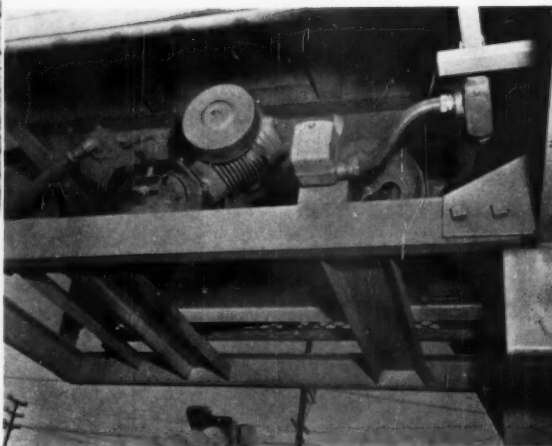
Automatic lockout on scale beams is accomplished pneumatically—the *fourth* function of air power. This eliminates rebatching the same materials.

Finally, air is used to blow dust and materials from the machinery in clean-up operations, the *fifth* function.

There are a number of reasons why Noble engineers use pneumatic control power—all of them basic and applicable in other fields besides concrete batching assemblies. For example, compressed air



NOBLE-MOBILE The 28-ton-capacity, 3-compartment aggregate bin of this batching plant is charged with a crane. Twin feed screws operate through the horizontal cement silo and have their flow into the batcher cut off by pneumatically actuated louver gates. Air also powers clam shell gates at the bottom of the aggregates bins, as well as the batcher dump gates. All air for these, as well as two other major operations, is provided by the Type 30 Ingersoll-Rand compressor in the close-up view (right). The 2-stage, 10-hp, base-mounted unit, with its 120-gallon receiver, is located out of the way on a frame beneath the cement storage compartment (above).



provides instantaneous reaction with the force necessary to do the job at hand. In this case, rapid batching cycles are essential for profitable operation. This is especially true in high-output plants. Air not only makes it possible to maintain speedy operations, but equally important, it does so without sacrificing accuracy. Further, compressed air systems are relatively simple and trouble-free—especially so because of recent advances in collateral industries, making, for example, superior fittings and flexible hose. Pneumatic systems are light in weight and can be maintained easily.

Ingersoll-Rand compressors have been selected for all the Noble batchers because they not only provide the general advantages of air systems, but they meet the heavy-duty, easy-to-service requirements as well. Each cylinder is cast separately, and valves can be changed without breaking and reconnecting the air lines. Each compressor is equipped with an inlet filter and muffler which is especially essential in the dirty and dusty atmosphere in which these batching plants operate. Further, the internal working parts are protected by a sealed crankcase, which is vented to the filtered side of the filter, assuring no contamination of the lubricating oil, etc. These design features are key factors when time is important, as it always is, especially to the contractor. Any long interruptions to service equipment cannot be tolerated if daily profits are to be assured.

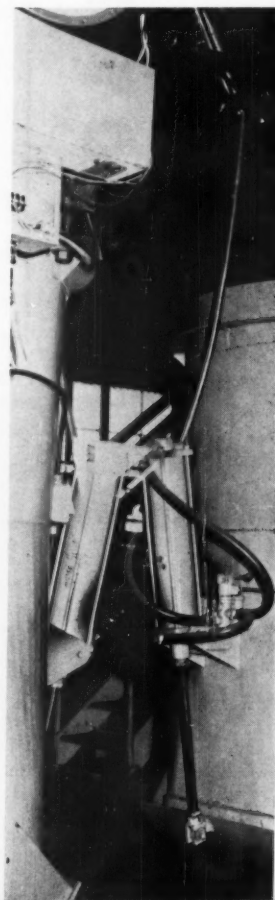
One of the Noble batchers—reported to be the world's largest—is the plant at

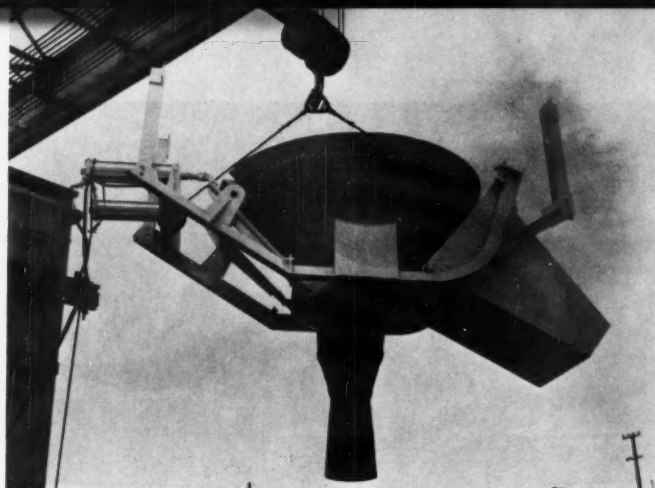
the Glen Canyon Dam on the Colorado River in northern Arizona. Since construction of this dam will consume 5,000,000 cubic yards of concrete, a comparable batching plant was needed. The one furnished by Noble is impressive, rising 217 feet from bearing plate to the top of the screen. Its bins and silos hold 3000 tons of aggregates and 200 carloads of cement. There are six 4-yard tilting mixers under the plant, and, as with the other company batchers, compressed air is vital to its smooth performance.

Batch-A-Bout is the smallest unit made by the Oakland firm, and, a priori, is turned out in far greater quantity than those assemblies of the size used at Glen Canyon. Designed to meet the needs of the workaday construction industry, it is portable and has a medium-output rating. The Batch-A-Bout finds applications in building all nature of structures, curbs, gutters and the like. Each plant carries with it either a 5-hp, 24-cfm or a 3-hp, 15.8-cfm compressor. The line between the special-built Glen Canyon unit and the Batch-A-Bout models contains several other assemblies—stationary plants in a variety of sizes and arrangements utilizing 15-hp, 81.8-cfm compressors to provide the required 100-psig pressure air.

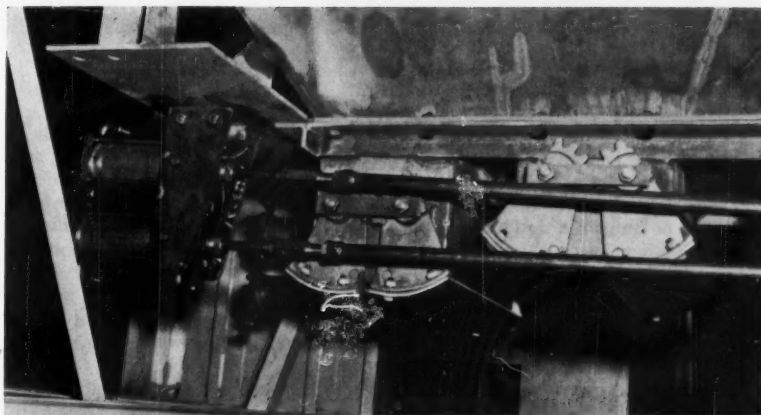
The illustrations on these two pages show two of the Noble units—the Batch-A-Bout described, and the Noble-Mobile. The other pictures show some details of the air applications on batching assemblies.

Air



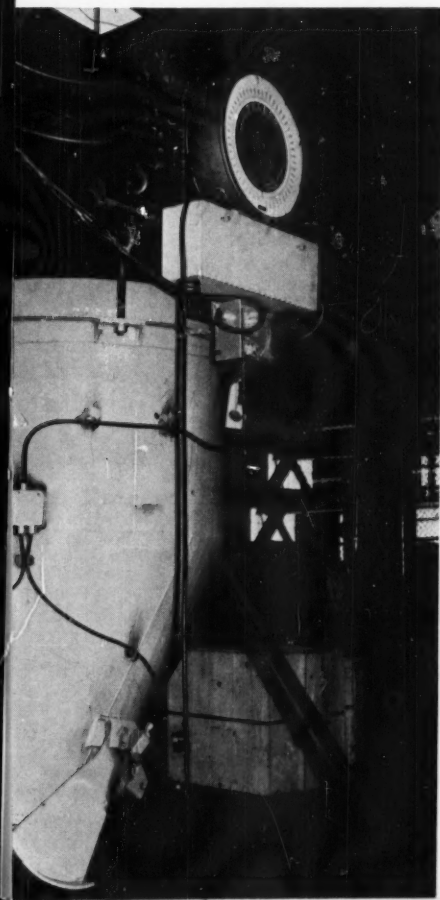


Air rams at the left change the chute, shown left, under a gathering hopper. The water-jacketed hopper is shown in operating position, while the dry-batch chute is swung up and out of the way to the right. Note the inlet pipe to which a flexible water hose is connected when the plant is completely set up.



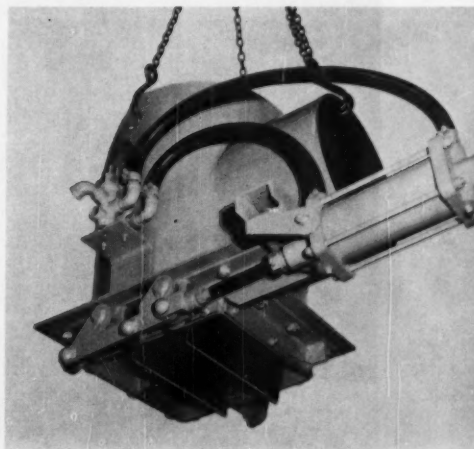
Above are two of four clam shell gates through which aggregates are released. Note the four air rams (left) by which the gates are automatically opened and closed.

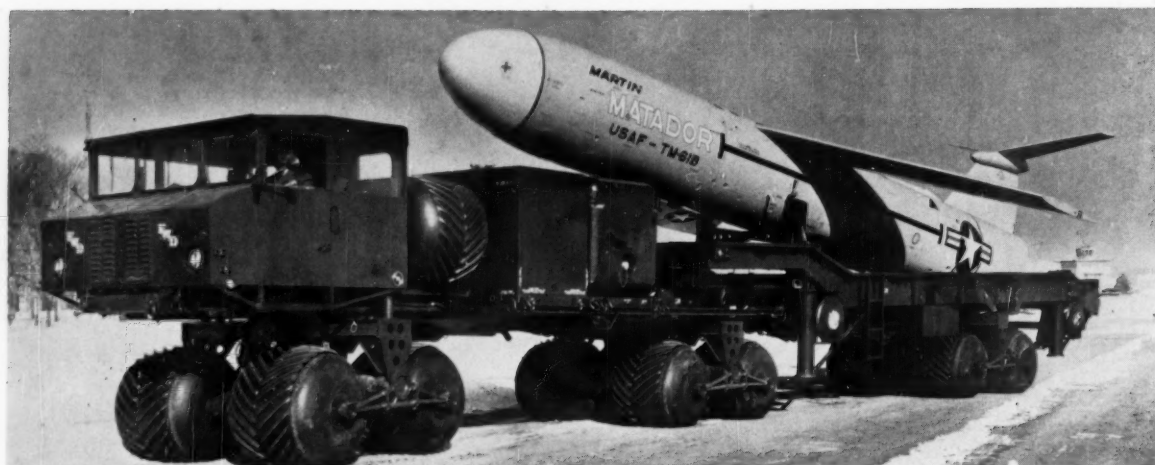
Functions



The photograph at the left is of an aggregate batcher. It illustrates the relationship between the scales and the air ram that opens the dump gate after the batch reaches a predetermined weight.

The detail below is of a louver gate, the air ram that activates it, and the solenoid valve that controls the ram. This subassembly is used at the end of a cement feed screw.





WHEN the Terra-Tire made its debut at Goodyear Tire & Rubber Company 6 years ago, it was a signal for producers of industrial and commercial vehicles to design special equipment that had previously been impractical.

The nickname, "go-anywhere" tires, is apt. Constructed of nylon, they range in height from 16 to more than 60 inches and are sometimes as wide as they are high. They can go virtually anywhere conventional tires cannot. This is because of an extra-large "foot print" (large contact area), low rolling resistance, low ground-bearing pressure, high strength, and good flexibility. Terra-Tires can carry vehicles over rocky ter-

rain; through mud, sand, snow and swamps; and can actually float vehicles.

The 6-year period since the birth of the Terra-Tire has brought about the design and manufacture of some most unusual vehicles: missile carriers, marsh buggies, and "tree-knockers," to name a few. Also included in the list of Terra-Tire-equipped vehicles are farm tractors, scrapers, graders, golf carts, mining-equipment carriers, logging tractors and many others. Some are illustrated here. Terra-Tires move heavy drilling equipment over rocky, roadless terrain, and in Pakistan, the same transporters carry drilling material over soft marsh lands and through shallow rivers.

These



EASY GOLFING Soft Terra-Tires provide insurance against damage by golf carts to fairways. Because of the high flotation and low ground-bearing pressure, carts can even be driven through sandtraps—without digging into the sand—although this is not a recognized practice. Even when fairways are rain-drenched, the tires will not sink into the turf.

SAFE MACE One of the first applications for oddly shaped Terra-Tires was on ground-support equipment for the U. S. Air Force's Matador missile, called the Mace. The tires were selected because of their ability to deliver a soft ride over all types of terrain. The ones illustrated are 42 inches high, 40 inches wide and 10 inches across the hub.



PICKING PEAT Peat harvesting has been mechanized through the use of a scraper and tractor equipped with soft-riding tires. Millburn Peat Company officials at Otterbein, Ind., report that the new method results in greater production with lower operating costs than is possible with dragline operations.

Tires Will Go Anywhere



TREE-KNOCKER The tricycle pneumatic Tree-Knocker, manufactured by A. D. Goodwin & Son, Inc., Manteca, Calif., is used to butt nut trees, knocking the nuts to the ground. To avoid crushing the fruit, the vehicle is equipped with soft, smooth-skinned Terra-Tires enabling the knocker to virtually tiptoe through the pecans without damaging them.

NO-RUT TRACTORS Use of these porky tires provides a smooth carpet for the thoroughbreds at Santa Anita Park, Arcadia, Calif. The tractors are used to scrape the track after a rainstorm. Conventional tires cause ruts, but these float the vehicles over the surface.





This and That

Fun For Junior Contractors

In January, the U. S. Patent Office granted Marvin I. Glass of Chicago, Ill., a patent for a toy pneumatic drill. The inventor was Carl Ayala, and his device looks like the air hammers that workmen use to rip up pavement. When the "tool" is held by its handle, and its end pressed on the floor, an internal hammer is actuated, making a short series of noises. When the handle is released, a spring pushes out the end again, repeating the rapping.

★ ★ ★

Airborne Coffee Maker

The U.S. Navy is getting four blimps of a type largest in the world. There apparently is some interesting relationship between the size of a blimp and the need for auxiliaries, for a full third of the fuel that the huge gas bags carry is used to generate electricity. The ships have more than 125 motors from $\frac{1}{100}$ to 18 hp in size. Some of these power blowers that supply 95 tons per hour of pressurizing and ventilation air. (Compressed air is used to control ascent and descent.) The electricity also operates electronic gear equal in consumption to 150 television sets, and heats an electric range and coffee maker.

★ ★ ★

Steam Plant's Bedrock Incasement

The first unit of a 700,000-kw steam power plant in Sweden has recently gone into operation, and amounts to about 22 percent of the total proposed capacity for the facility. The plant is located on the west coast, north of Gothenburg, and is unique in that it is entirely incased in the solid bedrock of a mountain just outside the community of Stenungsund. The only visible parts are the smoke stacks, towering 280 feet above the ground level, and the main switchgear plant which feeds the 130,000-v power into the grid network.

Initial construction on the Stenungsund plant began in 1955, at which time the plan called for two 100,000-kw sections to be built. As construction pro-

gressed, it was found that it was possible to raise the total effective capacity through new designs, the introduction of intermediate steam overheating, and the like. The next section to be finished will be rated like the first—as 150,000 kw. Its completion is expected this fall; the entire project should be finished near the end of the decade, at which time the facility will probably be the biggest underground steam power plant in the world. When the first building stage is done in the autumn, some \$40 million will have been invested by the Swedish State Power Board. The plant will have doubled the Board's thermal power capacity in less than 1 year.

A wide variety of rock drilling and mucking equipment was used in the construction, for it was necessary to remove 1,570,000 cubic yards of rock to form the four underground machinery halls, access tunnels, and chambers that make up the facility. Each of the two halls in the first building stage has a length of 410 feet, a width of 60 feet, and a height of 98 feet. The two remaining bays are somewhat larger. Each machinery hall forms a separate unit and includes ventilation equipment, boiler, high- and low-pressure turbines, generator and transformer. The unit for separating solid particles in the smoke gases treats about 32,100,000 cubic feet of gas an hour with a purification degree of 90 percent. For cooling, sea water is used.

The planning and construction of the Stenungsund plant was carried out by the State Power Board, while the mechanical equipment—the turbine plant, the boilers, the extensive ventilation equipment, transformers, switchgear plant, etc.—was supplied by leading Swedish industries. The boilers are of the horizontal type and have conventional components, such as preheater and economizer. Each boiler consumes about 35 tons of Bunker C type oil per hour, and the peak temperature at the sixteen burners is 9092° F (1700° C). From the boiler, the steam is conducted to the high-pressure turbine and back again for intermediate heating before being fed into the low-pressure turbine. Although this system entails a longer starting-up period than is usual, it is said to insure improved operational economy.

The turbogenerators, of which the

high-pressure unit has a rating of 39,000 kw and the low-pressure one of 111,000 kw, are of essentially new design. Both were planned for a speed of 3000 rpm, and for the first time in Sweden, hydrogen has been introduced as a cooling medium. From the generators, the power is transmitted over aluminum rails, incased in steel tubes, to the main transformer. A joint control room, situated between the two machinery halls, serves both the first and the second sections of the facility, the operation of which is automatic.

★ ★ ★

Venders Swallow Billions

The year of 1959 found vending machines firmly established in the regions of big business. They took in more than \$1 billion in coins during the year, according to R. Z. Greene, chairman of the executive committee of the Automatic Canteen Company of America. It was also reported that sales of the machines had reached more than \$2 billion. Cigarette dispensers continued their sales growth by \$10,000,000 over 1958, but this was not as great an advance as was seen in vending machines that dispense sandwiches and pastry—they were up 81 percent over 1958. The spread of automatic cafeterias, especially to employee lunchrooms, is accounting for a part of this, and Greene states that the industry may soon be producing individual venders that can sell 100 or more items, either refrigerated or hot, at a wide variety of prices.

★ ★ ★

Giving Vehicles The Air

In June 1958, *Compressed Air Magazine* published an article entitled "Glideair," that discussed Ford Motor Company's research and development of the Levapad. It generated so much reader interest in wheelless air-supported vehicles, it might be well to compare this Ford Levacar with other vehicles. There are three groups of wingless, air-supported vehicles: those lifted by reaction of a jet; those supported by a blanket of low-pressure air; and those supported by a thin film of relatively high-pressure air.

In the first category are the various VTOL (vertical take off-landing) "airplanes" that have been recently making news. Several systems are used, the latest being a turbine-driven fan (a propeller powered by a jet engine, as the Viscount's and Electra's propjet, but encased in a tube, hence "ducted") that blasts down to lift the stub-winged plane off the ground. When airborne, these ducted fans tilt slowly from the vertical to a horizontal position, driving the plane forward.

In the second category are the air cushion vehicles that operate with low-pressure air forced down over a large area. These vehicles lift to a comparatively higher distance off the ground than those in the third classification, in some instances to a height of several feet. They are highly mobile over rough terrain and water, but are limited to about 60 mph over land and 25 knots over water. Because the low-pressure air system requires a large support area, vehicles operating on this principle are severely limited in minimum width and width-to-length ratio. They are further extremely sensitive to shifts in the center of gravity because of their high clearance. In some cases, even movement of the operator will cause tilting.

In the third basic group are the Ford Levacars in which Levapads lift the vehicles only a fraction of an inch. They cannot operate over rough terrain or water, but are designed to function over twin rails, like trains, but at speeds as high as 500 mph. The Levapads can be designed in almost any shape and have little influence on the minimum width of a vehicle equipped with them. The power requirement for Levacars is roughly one-sixth that required for air-jet supported vehicles, and one-third to one-half needed for low-pressure air-cushion types of the second group.

★ ★ ★

The Ambulatory Commuter

Ingenious Mathematical Problems and Methods is the title of a fascinating book published by Dover Publications, Inc. Its 237 pages are crammed with 75 "Provocative Problems," and their answers, along with 25 "Challenging Quickies" and "Mathematical Nursery Rhymes." For 18 years *Dial*, the company publication of Graham Transmissions, Inc., has run a series of articles "Private Corner for Mathematicians." The interest generated by this led to the republication of much of the material in the present book. Here's a sample of a quickie:

Mrs. Suburban Graham met her husband at the station with the family car promptly at 5 P.M. every day, averaging 30 miles per hour each way. One day Mr. Graham, without notifying her, caught an earlier train which arrived at 4 P.M., and started walking home. Mrs. Graham picked him up part way and they got home fifteen minutes earlier than usual. How fast did he walk?

The solution to "The Ambulatory Commuter," which is quoted from the publication, appears on page 35 of this issue, and the method of arriving at it is explained in L. A. Graham's book. Incidentally, the author says that the problem can be rapidly solved if the right approach is used—and on the average, 5 minutes is required.

Who today isn't familiar with the words *megaton*, *kilowatt*, *microinch*, etc? The prefixes used are standard. Now these have been supplemented as a result of recommendations made by the International Committee on Weights & Measures to the U. S. Bureau of Standards. The prefixes denote multiples and submultiples of units. In the list below, eight numerical prefixes are in common use; those marked with an asterisk are new.

1,000,000,000,000 (10¹²)—is tera* (T)
1,000,000,000 (10⁹)—is giga* (G)
1,000,000 (10⁶)—is mega (M)
1,000 (10³)—is kilo (k)
100 (10²)—is hecto (h)
10 (10¹)—is deka (dk)
0.1 (10⁻¹)—is deci (d)
0.01 (10⁻²)—is centi (c)
0.001 (10⁻³)—is milli (m)
0.000001 (10⁻⁶)—is micro (μ)
0.000000001 (10⁻⁹)—is nano* (n)
0.000000000001 (10⁻¹²)—is pico* (p)
Thus, for example, 10⁻¹² farad is called 1 picofarad, and is abbreviated 1 pf.

Mining Study-Work Program

A student-trainee program to supplement the regular 4-year curriculum in mining engineering is being inaugurated by Penn State University for summer, 1960. The new plan has resulted from concern about the small numbers of engineers currently entering this field. The program will go into effect in July and is designed specifically to benefit companies in the mineral industries by providing a steady supply of technical personnel. Trainees will be selected from the ranks of employees and recent high school graduates. Students will attend school 6 months, then work in industry 6 months, over a 4-year period. The fifth year will be entirely academic. Though the curriculum to be followed will be identical with the present one, it will be rearranged to permit the student to obtain his bachelor of science degree in 5 years. Participating companies will provide employment to students for alternating periods as engineering trainees. To maintain job continuity, most com-

Compressed Air Oddities



IN 1905, C. S. Magill, of Owensboro, Ky., obtained a patent on a combination eraser and blowgun that was calculated to be a boon to typists. The idea was to bore a hole in a conventional eraser just large enough to admit the discharge nozzle of a rubber hand bulb. The typist was to use the eraser in the usual manner to remove faulty characters, then blow away the accumulated material by holding the eraser just above the paper and squeezing the bulb. It is not believed that many were sold.

DURING World War I, the engineer corps of the Austrian army carried air bags that could be blown up and used as pontoons for bridge construction or, in emergencies, even as boats. Made of waterproof canvas, the bags were about 5 feet long and half as wide and could be rolled up compactly for transport. When needed, they were unrolled and

inflated by lung power, the orifice then being closed and secured by a clamp. A plank 10 or 12 feet long lashed to two bags would support several men and a row of such sections would form a serviceable bridge.

THE potters of ancient Peru manufactured an ingeniously contrived musical instrument that may very properly be called a whistling jug. In collections of antiquities, it is called a *silvador* or *silvio*. Specimens are obtained from old burial places in Peru. One of these consists of two vases, the bodies of which are joined, with a hole or opening between them. The neck of one vase is molded into the representation of a bird's head and is closed except for a small opening in which is inserted a clay pipe leading to a whistle.

When a liquid is poured into the open-necked vase, the air is compressed in it and in the adjoining one. There it escapes through the clay pipe and sounds the whistle hidden within the bird's head.

The sounds of these jugs represent the notes of various birds. One in a collection at the British Museum imitates the sounds of the robin and another one those of a thrush tribe that is peculiar to Peru. Smaller models are made for blowing by lung power.

panies will sponsor pairs of students so that one student is working while the other is in college. Student-trainees entering the program will be selected by either the Department of Mining at Penn State or by co-operating companies. They must meet University entrance requirements and maintain satisfactory grades to remain in the program. Among concerns participating are: Climax Molybdenum, General Crushed Stone, Hanna Coal, Harbison-Walker, Island Creek, and Jones & Laughlin. Interested candidates may apply to the University.

★ ★ ★

A Clean, Clean Room To further quality control of aircraft and missile filters, Purolator Products, Inc., has designed and built a "clean room" where filtration elements are subjected to metic-

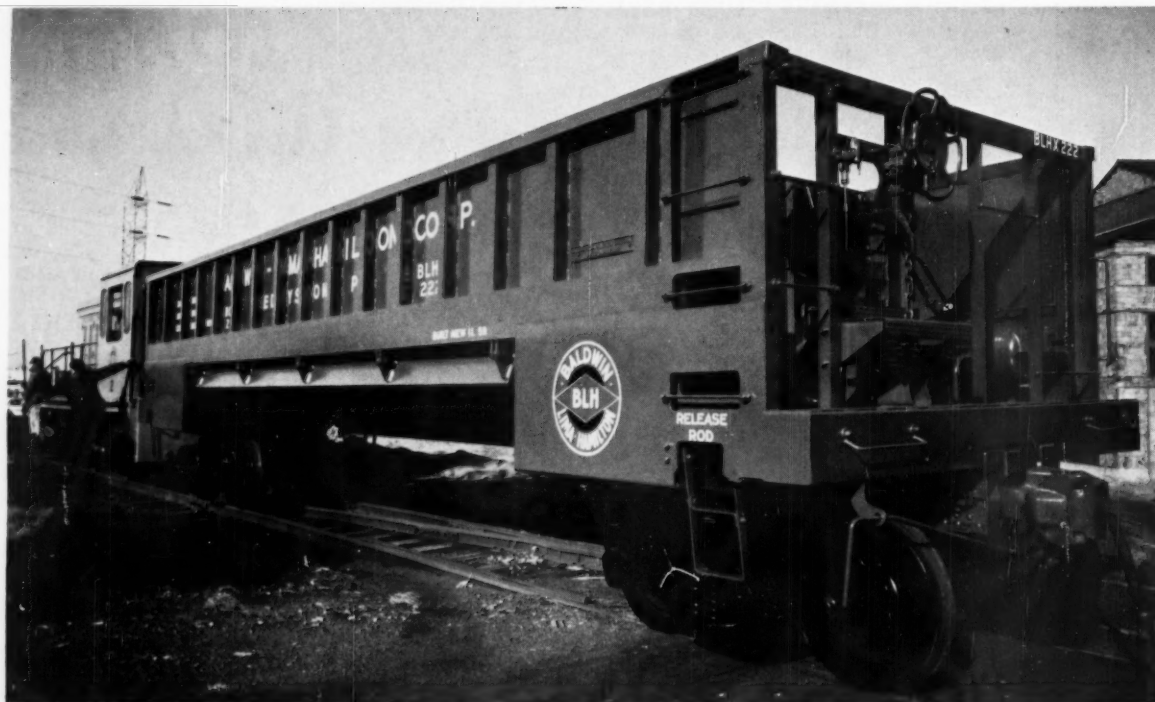
ulous ultrasonic cleaning procedures. The structure is under 24-hour pressurization and can be entered only through an air-locked chamber where personnel don lint-free clothing, including shoe boots and full-length coats. Only two persons can enter the room at a time as one of the chamber's cleanliness controls. Air is filtered before being forced into the room. To minimize costs, air is pulled from an adjacent office air conditioning system by a roof-mounted blower. This ensures proper working temperatures year-round without the cost of additional cooling and heating equipment. Air is exhausted through a roof stack by an auxiliary exhaust blower. Should cleaning fumes from boiling detergent solutions and chemical degreasing agents become excessive, it can be turned on temporarily to purify the air.

Air samples are taken every other day to ensure control of maximum cleanliness. Millipore samplers, placed on the

laboratory counters, are one of the means used to check particle settling rate. After being exposed for 2 hours, the paper samplers are checked under a microscope. To date, the maximum particle-settling rate has been nine particles, measuring 7 to 25 microns, and five particles, measuring 25 to 50 microns, in any 2-hour period. It is reported that there has been no trace of any particles over 50 microns. All air samples are compared with samples from other plant areas to determine the level of cleanliness maintained in the filter cleaning chamber.

In finishing the room, Purolator selected a light-colored flooring for its psychological effect. Walls and ceilings are covered with a polished surface vinyl fabric, and a sealer was used to coat the vinyl floor so that cement dust could not seep up through the tiles. Shatter-proof windows, one on either side of the door, permit observation.

Air Doors Unload This Gondola



Of an entirely new design, this 88-ton, 950-cubic-foot capacity dump car was built by Eddystone Division of Baldwin-Lima-Hamilton Corporation. Among its new features are two air-operated doors, 9 $\frac{3}{4}$ feet wide and 21 feet long, that open at the bottom of the car for a quick and complete dumping. Opening and closing of the doors is controlled by a single lever which actuates four pneumatic cylinders. Movement of the control in one direction opens the doors; movement in the opposite direction closes them. If the operator releases the lever, it will return to the neutral position—all air cylinders are open to atmosphere so no seepage or air leakage can actuate the cylinders. An "over center" lock position on each door mechanism assures that the doors will not open accidentally. A spring-loaded pin in the cylinder head drops into

a notch in the actuating piston rod. Before air can enter the cylinder to open the door, the air must pass through a chamber which lifts the pin out of the notch. An air reservoir, 30 inches in diameter, 60 inches long and charged at 90-psig pressure, contains sufficient air to open and close the doors once without recharging. Normally, air is supplied by the compressor of the locomotive pulling the train. In addition to the pneumatic doors, the sides of the car slope slightly outward at the bottom, and are specially painted to further eliminate the tendency of materials to adhere to the sides when it is emptied. Thus no clamshell buckets, vibrators, hand shovels or sweeping will be required to clear the load from the car. The gondola is currently on field tests, and the manufacturer hopes to go into full-scale production soon.

EDITORIAL

Paper



PAPER'S most important raw material is water. An unusual statement? Perhaps, but industry experts estimate that the amount of water required for a ton of paper is rarely less than 50,000 gallons and often is as much as 200,000 gallons. This being the case, somewhere between 200 and 800 pounds of water are required for each pound of paper produced. It is not exactly right to say that all of that water is used—a better term would be *handled*. Actually, very little water is expended.

The mythical average American uses 400 pounds of paper a year. Where does all of it go? Current newsprint requirements alone in this country call for 6,800,000 to 7,000,000 tons annually. Books, construction paperboard, packaging, magazines: all take their share. The demand for the output of the 4900 pulp, paper and products manufacturers in the country has pushed the industry into the top ten United States manufacturing industries.

ANY discussion of the use and manufacture of pulp and paper in the United States is incomplete without a few words about the role played here by the Canadian industry. Five million tons of newsprint are exported to the U. S. annually by Canada—roughly 75 percent of current needs. This export takes about three-fifths of the vast Canadian output of pulp. An additional one-fifth is also shipped abroad as raw pulp, again largely to the United States. (The latter shipments comprise about 8 to 9 percent of U. S. requirements.)

The paper industry in this country and in Canada has grown at a rapid rate. Indeed, between 1955 and 1958, combined newsprint capacity surged forward a startling 1.9 million tons, a 25 percent increase in annual capacity. Sales of paper products in the United States doubled in dollar value between 1947 and 1958 when the figure reached \$10 billion for the first time. In this country about \$6 billion was invested in new plant during that span. In the same interval, Canadian producers put about \$1.3 billion into plant expansion.

DEMANDS for paper have resulted in corresponding demands for water. Handling it assumes a role of fantastic proportions when the number of gallons of water per ton of paper is multiplied by the total tonnage production. The figure is so large that it is meaningless. It gains somewhat in comprehension if compared with the flow over Niagara Falls: the annual discharge of that cascade is but one-fifth of the annual requirements of the paper industry!

The industry as a whole practices one of the most comprehensive water conservation programs in the nation. A gallon of water in an average mill is used over and over again. It is handled not only as water but as a variety of mixtures and

suspensions. It carries the cellulose fibers of the paper itself, bleaches, sizes, digesting fluids, dyes, etc. It may be handled hot or chilled.

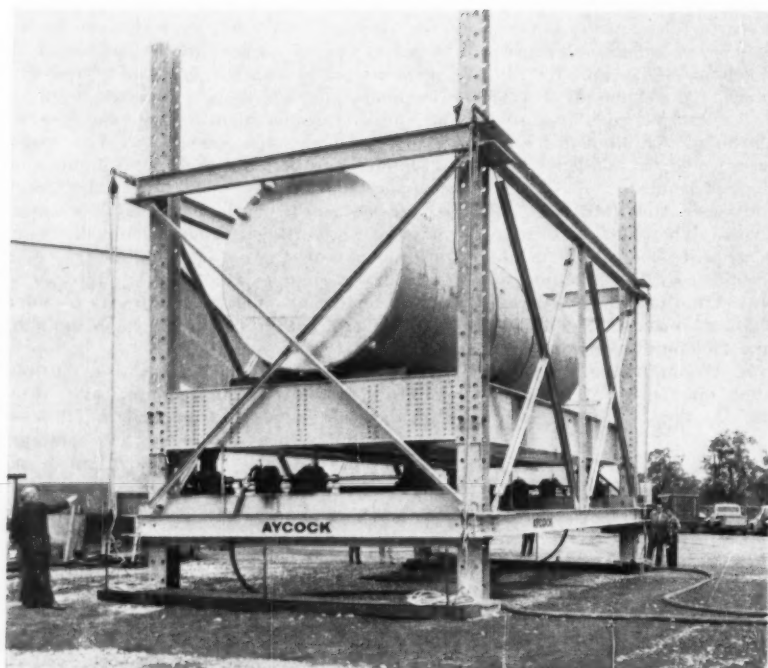
It is pumped back and forth, through settling tanks, Jordans, digesters, cookers and finally through the paper machine itself. Not only is it pushed around by pumps, it is pulled by a variety of vacuum equipment ranging from reciprocating and positive displacement rotary machines to ejectors and barometric condensers. The design and building of the water handling equipment of the paper industry is a field in itself. Recent years have seen the development and wide application of a centrifugal pump having diverging (instead of converging) impeller vanes. The ability of this pump to handle large gulps of air as well as significantly higher percentages of stock has made itself felt throughout the paper and pulp industry.

Pump materials, too, have made great contributions to the advance of the paper industry. Handling the acids and alkalis of a modern mill is no easy task and a variety of metals are combined with specialized stuffing box designs to collect and contain seepage through the pump seals. These and many other design innovations were often originally produced for the pulp and paper makers only but have now spread to other industries. Impeller designs play a big part in the proper design of machines for pulp and paper work. Fan units, for example, handle the stock going to the Fourdrinier head box, a task calling for high capacity, low to medium heads.

In an effort to reduce the amount of water required in paper manufacture, some plants are now using a rotary positive displacement vacuum pump for drawing water from the felts and wires of the Fourdrinier machine. The unit requires about 2 percent of the sealing water required for previously used wet-vacuum pumps and in addition is lighter and more efficient.

RELIABILITY is a feature of the new centrifugal and vacuum pumps going to pulp and paper makers today. A single new integrated mill can cost as much as \$60 million and when dealing with figures of this magnitude, no weak links can be allowed. Putting a \$60 million investment out of commission for only a few hours can run up some fantastic down time charges. Yet there have been such advances by suppliers to the industry that much accessory equipment now operates alone without standby equipment. The industry, as did many others, used to buy three one-half capacity pumps, for example, to handle a given job. Two were in service with the third standing by. Now, in some cases, a single full capacity machine is installed. Much of the credit of course, must go to well-planned and executed preventive maintenance programs. Yet we feel that it is a tribute to suppliers that so important a task as, for example, the handling of a flow equivalent to five Niagara Rivers can be entrusted to equipment serving without standby.

A Husky "Monkey" Scales a



DEMONSTRATION Here, for demonstration purposes, the Aycock unit raises a large steel tank in lieu of a generator stator. Between the load carrying beams and the elevator beams are visible the air motors, gear reduction units, shafts and jacks. The elevator is erected here with 30-foot-high columns.

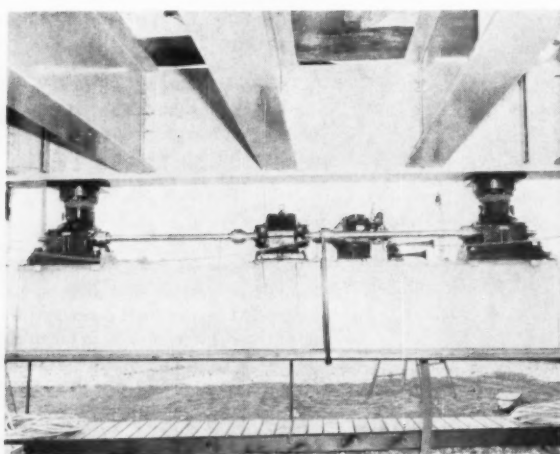
"JUST like a monkey climbing a pole." This is how Aycock, Inc., machinery installation contractors of Camp Hill, Pa., describe the action of their Mark II Stator Elevator, an air-powered lifting device that can hoist heavy objects of as much as 400 tons. The Stator Elevator is primarily intended for installing power plant generator stators but can also handle equipment such as large presses, or can be placed on rollers to work as a gantry crane.

Essentially the Stator Elevator consists of a structural steel framework. Moving vertically within the framework are horizontal load-carrying beams above and a pair of jacking beams below. Four 100-ton-capacity worm gear jacks rest on the jacking beams and push upward against the bottom of the load carrying beams. Once the jacks have pushed upward for 30 inches, their highest extension, pins are placed through the load beams into the vertical framework and the load is anchored. The jacking beams are then raised and pinned so that the jacks can again make full use of their extension.

The jacks are Duff-Norton units which are capable of raising far more than their rated capacity. The four jacks can lift a total 600 tons, which provides a 200-ton safety factor. The units work at about 2 inches per minute and require 16,000 inch-pounds of torque at full load. Powering each pair of jacks is an Ingersoll-Rand Model HH5UM Air Motor



AIR SUPPLY An Ingersoll-Rand Gyro-Flo 600 rotary air compressor supplies the air for this test. Either portables or ordinary plant air can power the air motors.



JACKS This view shows two jacks in operation with a load carrying beam above and a jack beam below. Between the two beams at right can be seen a small red bulb that lights when the load beam is not level.

Pole

controlled by a throttle lever. Each air motor runs through a Philadelphia parallel shaft gear reduction unit with double extended output shaft. Some 600 cfm of air consumed for the air motors comes from a portable compressor, as shown in the accompanying photographs, or from plant air. The motors are rated for air pressure of 90 psig.

A normal sequence of action with the Aycock Mark II Stator Elevator (it supplements an earlier model of smaller capacity) goes like this. The unit is erected over the railroad car that delivered the generator component. The stator is usually picked up by straps, designed for this purpose, and the rail car is removed. The stator is then raised and an auxiliary platform is inserted below the stator. The top suspension system is then removed and the lower platform is jacked to final elevation. This is where the "monkey climbing"—shinnying—occurs. The stator is raised 30 inches and the load carrying beams pinned. Then the air motors direction is reversed. Because the jacks are anchored to the jacking beam, this reversal causes the jacking beams to be raised as the jacks recover their expended extension. The jacking beam pins are inserted, and the cycle resumes. The generator platform stays within 1/2 inch of a level position during the lifting cycle; should this tolerance be exceeded, a mercury switch actuated by the loss of the level

Saving With Air Power Application



condition flashes a red light near the faster motor. This air motor's speed is reduced temporarily as the platform regains its plumb. Approximately 25 feet of elevation can be accomplished in 1 day.

Occasionally when a stator is delivered, the elevator can be placed below the railbed grade and the stator can be rolled directly from the railroad car onto the platform. This is rare, however, and usually the stator must initially be suspended from the elevator with straps. The lifting beams are of much heavier material than the jacking beams because concentrated moving loads develop when a stator is rolled on or off. The elevator has 40-foot-high columns as there appears to be no reason for a higher unit, but the elevator could go to a greater height if taller columns were provided.

The Aycock device, with its husky and convenient air-motor drive, provides a quick and safe method for handling large and heavy components. The time required for use of the machine varies with the erection job, but the method is far faster than the old method of jacking, wedging and shoring of timbers. Often about 2 weeks are needed to raise a generator stator to elevation; the Aycock

Stator Elevator can do the same work safely in one 8-hour shift.

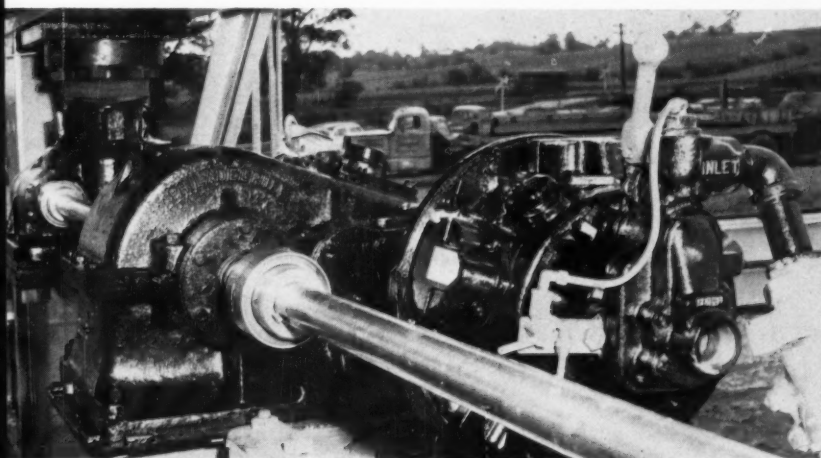
Aycock Inc. designed and built the Elevator for use by the concern's own contracting organization in power plant machinery installation work. It is currently being used to install four 305-ton generators for Public Service Electric & Gas Company at the Mercer Station near Trenton, N. J. These generators are reported to be the heaviest ever shipped by General Electric Company.

Clearing Snowy Runway Lights

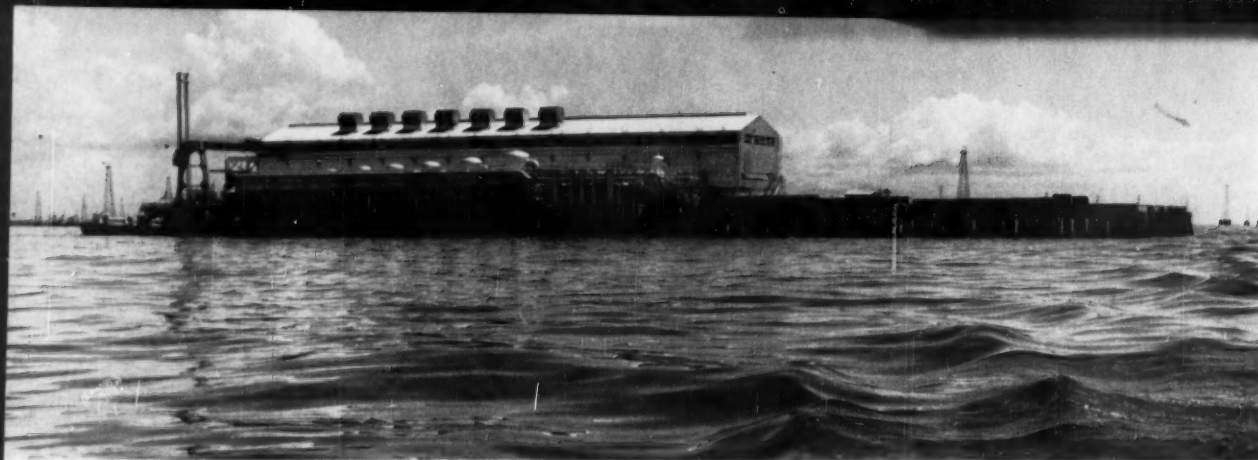
THE TASK of clearing snow from airport lights at Fairchild Air Force Base, Spokane, Wash., once took 27 men 4 hours; now it is done by one man in 1 1/2 hours.

Ingenuity, and an Air Force cart housing a small AiResearch gas turbine, were teamed to produce the time and labor saving method. Fairchild maintenance crews designed a nozzle and clamp to direct hot bleed air from the turbine toward snow and ice that covered runway lights. The hose was clamped at a 30-degree angle across the rear of the cart. The unit then was towed along the runway with the hot-air blast pointed at the lights. The snow and ice melted away, revealing a bright cleared light, welcome to the eyes of incoming pilots. With the new method, protected lights are cleared without removal of their grates. Also lens breakage—a former problem—is stopped.

The turbine use follows past development of AiResearch turbines for aircraft deicing. In an earlier instance, removal of as much as 2 feet of snow that accumulated on B-52 jet bombers took 2 hours and cost \$750. Glycol solutions were used. The job was cut to a 30-minute one costing \$37.50 by applying a turbine and a crane-mounted air nozzle. AiResearch Manufacturing Company is a division of the Garrett Corporation, Phoenix, Ariz.



POWER Compressed air operates the Ingersoll-Rand HH5UM Air Motor at right; this motion is reduced by the Philadelphia reduction gear at center which in turn transmits the motion to the shaft. At left is one of the Duff-Norton jacks driven by the shaft.



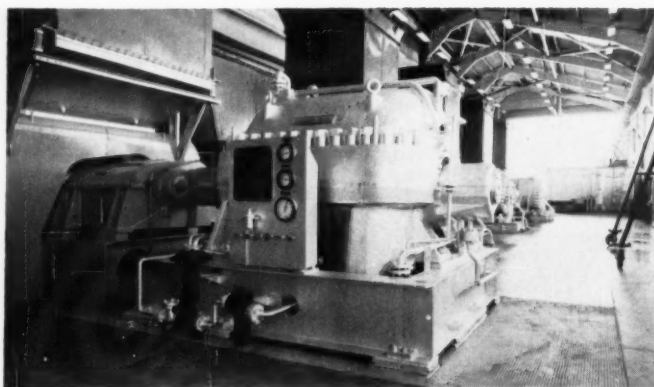
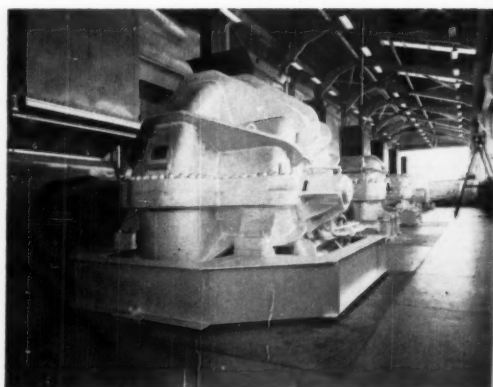
more gas below MARACAIBO

THAT teardrop atop South America, Lake Maracaibo, is becoming well dotted with the workings of oilmen. On this page are pictures showing Creole Petroleum Corporation's Tia Juana No. 3 natural gas pressure maintenance station, the company's latest offshore facility for returning gas to its home strata. Tia Juana No. 1 and 2 have preceded it and a fourth such Creole installation, Bachaquero No. 1, is under construction. The Tia Juana stations are located in the Bolivar Coastal Field near the lake's east shore line.

Creole pumps the gas back into the Venezuela lake bed for several reasons. One is that gas is easily stored in this manner for future use. Another is that the injection of gas under high pressure increases the ultimate amount of oil that can be taken from the oil-bearing formations. A third reason is that injection reduces well operating costs because it encourages oil's natural flow. This obviates more expensive artificial recovery.

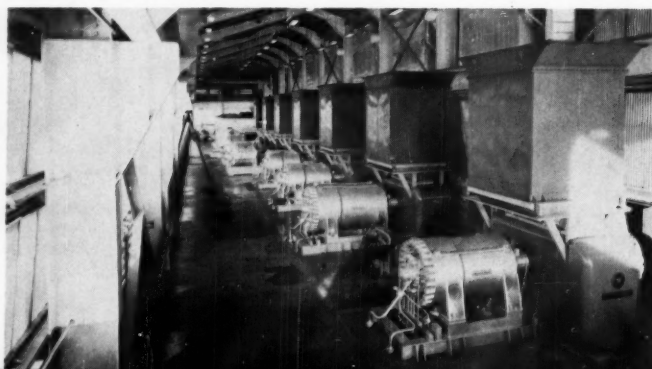
Tia Juana No. 3, like its sister installations, accepts the gas from flow stations after separation from oil, and forces the gas into the lake bed with centrifugal compressors. No. 3 is a 7-stage facility with seven Ingersoll-Rand compressors. The first-stage compressor is a double-flow one that receives the gas at 31 psia and raises its pressure to 59 psia. The next two in the train are multistage, horizontally split machines. Gas leaves the third-stage casing at 154 psia. The four compressors comprising the final four stages have forged steel, vertically split casings. Final discharge pressure is 2036 psia. The inlet capacity of the first compressor is 61,235 cfm; inlet capacity of the seventh stage is 1376 cfm. Centrifugal compressors were selected for this application because their inherent tendency to be free from vibration reduces foundation problems. The stations are built high on piles driven into the lake bed in nearly 100 feet of water.

FIRST STAGE No. 3's gas first enters this Ingersoll-Rand double-flow unit at 31-psia pressure and is compressed to 59 psia. All seven compressors in the train have Westinghouse gas-turbine drivers.



HORIZONTALLY SPLIT Second (above) and third stages are horizontally split.

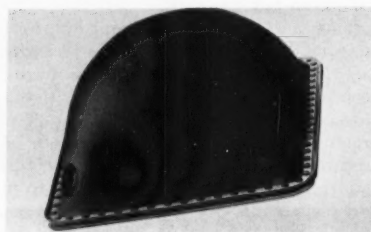
COMPLETE TRAIN Final four units are vertically split.





Industrial Notes

DESIGNED to eliminate flow stoppages in bins and hoppers that handle materials which tend to funnel, bridge and cake, a pneumatic bunker cushion achieves its maximum effect by the principle of positive displacement. When inflated with air at a pressure of 45 psig, Clouth Bunker Cushions exert a force of approximately 56,000 pounds. Operation is said not to jeopardize personnel and generates no damaging fatigue stresses. Basically the cushion consists of a rubber diaphragm bolted to a rein-

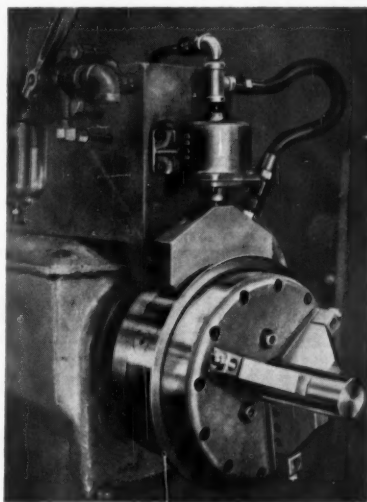


forced steel base that includes both an inlet port and an exhaust valve. It measures approximately $31\frac{1}{2} \times 39\frac{1}{2}$ inches when installed and reaches an operating height of $15\frac{3}{4}$ inches. Rubber shock cords connecting the membrane and exhaust valve provide complete mechanical control. Deflation cannot occur until the cushion has reached its fullest height. In addition, the cords serve to actuate the exhaust valve and relieve shock load stresses caused by the sudden removal of opposing load or falling materials. *Tressler Engineering Products Division, 17 Battery Place, New York 4, N. Y.*

POWRMATION is the tradename of a series of low-pressure air and hydraulic cylinders. Having a wide variety of mountings, rod diameters and rod ends, and offered with bores of $1\frac{1}{2}$ through 8 inches and resultant capacities of 250 psig (air) and 400 to 1000 psig (hydraulic), the cylinders are adaptable to

practically any installation. Mountings include side lug, center lug, basic, tie rod, flush side, front flange, rear flange, trunnion, clevis and double rod styles. Strokes can be made to any practical length. An extra-long bearing available with an optional gland makes internal spacers unnecessary in many long-stroke cylinders. A choice of packings meets high- or low-temperature requirements and the special needs of various fire-resistant hydraulic fluids. Standardized boots and rod scrapers give the cylinders added protection in installations that are extremely dusty or dirty. Catalog 1000 describes the Powrmation cylinder. *Hanna Engineering Works, 1765 Elston Avenue, Chicago 22, Ill.*

RETRACTABLE air couplings, each with a self-contained air cylinder for power chucks with through feed spindles, can be used with either automatically cycled or manually controlled bar feed machines. An air-actuated shoe contacts the periphery of the chuck adapter plate when the air valve is turned on. Re-



gardless of where the chuck stops, the shoe will be over one of a series of special valves incorporated in the adapter plate. After the part is in chucking position, the air is turned off and the shoe retracts. Use of the coupling eliminates

manually operated snap couplings or power wrenches, and reduces cycle time for load and unload stages. A unique valve system incorporated in the adapter plate permits interchanging various types of air-operated devices without disturbing the control set-up. At the present the couplings are applicable for devices operated on horizontal spindles only. *N. A. Woodworth Company, 1300 E. Nine-Mile Road, Detroit 20, Mich.*

AIR DRYERS, such as the one illustrated here, combine both mechanical and chemical methods for removal of all water and moisture vapors from compressed air systems. According to the manufacturer, dew points as low as



minus 20° F are obtainable with it. It is a 2-stage unit: the first stage utilizes a helical centrifugal chamber as a prefilter that removes all water and other particle contaminants, leaving only the vapor content of an air stream; the second stage is a desiccant (chemical) bed that reduces the desiccant consumption. The desiccant, called General Beads, is a polychemical base in small bead form and slowly dissolves during the process, requiring the addition of new beads only twice yearly; the desiccant never needs to be removed or heat-treated. Models are available in twelve standard varieties ranging to 2250-cfm free air capacities. Standard working pressures are 150 and 200 psig. *General-Erie, 1702 Peninsula Drive, Erie, Pa.*

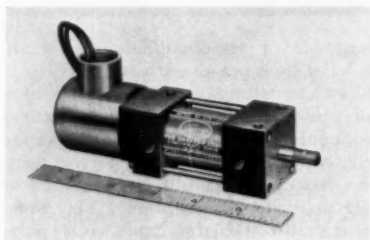
THE ACHILLES heel of properly made tension bolts and screws today is the shape at the bottom, or the root of the screw thread. This root should be larger, rounder and better controlled than it is on most industrial and aircraft fasteners, says Standard Pressed Steel Company's illustrated 20-page treatment of the subject—*The Root of The Thread*. The difference between a good and a poor thread root—perhaps only as little as

Quickie Solution (See page 29)

The Ambulatory Commuter walked at a rate of $4\frac{2}{7}$ mph.

0.002 inch in radius—may literally waste half the design load, or 99 percent of the fatigue life, of an otherwise sound fastener. Yet most standards are not very specific about the thread root, mainly because of undue concern over gauge interference, the SPS booklet states. The pamphlet, believed to be the first ever devoted to this problem, provides both designers and fastener users with a thorough review of the situation, covering: a listing of the basic criteria for a good thread root; comparative analysis of three widely used thread forms, including data on relative performance in tension-fatigue and at high temperatures; a complete specification for a large, round root radius that has been introduced in the aircraft and missile field; a capsule history of the evolution of this critical design aspect of the thread; and an informative preview, in effect, of some new large-radius-root screw thread standards that are expected in the near future. Copies of the booklet, fifth in a series on screw thread fundamentals being published by the company, are free of charge. *Standard Pressed Steel Company, Advertising Division, Jenkintown, Pa.*

VALVE-N-HED is the designation of extremely compact, lightweight cylinders of 1 1/8-inch bore. They are rated at 150-psig air pressure (250-psig oil pressure), and are ideal for tooling and automated



circuitry. The units may be obtained as spring return or double acting units, in 1-, 2- and 3-inch strokes from stock, with

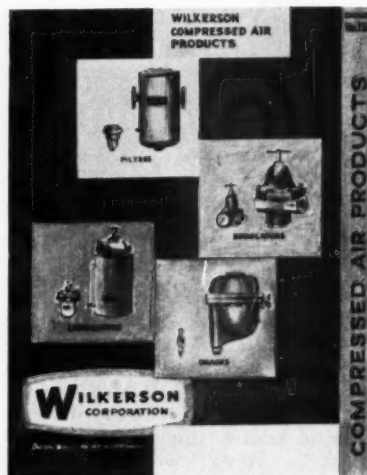
other strokes available. They are designed for 115-v, 60-cycle continuous duty operation at temperatures to 180° F, with power consumption rated at 10 watts. Others a-c and d-c voltages are also available. Each unit is supplied with grommet-type electrical outlet, or alternately with 1/2 NPT conduit electrical outlet and 24-inch thermoplastic covered leads. The cylinder itself is 1 1/2 inches square, with a very short over-all length. Complete details are given in Bulletin DIM-118. *The Sheffer Corporation, 326 W. Wyoming Avenue, Cincinnati 15, Ohio.*

COMPRESSED AIR PRODUCTS is said to be the first completely color-coded product catalog issued by any member of the pneumatics industry. It is the result of research into the needs and wants of distributors and customers for an easy-to-use technical catalog. Containing 24 pages, it presents the complete line of Wilkerson products, and represents a successful approach to the problem of enabling distributors to immediately find sections of a catalog covering products to recommend for a specific type of application.

Initial color coding begins on the front cover. A representative filter, regulator, lubricator and drain are pictured against colored squares. The squares, in turn, correspond with the color code of the appropriately tabbed inside pages.

The inside front cover features a schematic air-line layout with each type of Wilkerson product in place. Again, each product is color coded to the section of the catalog in which it is described in detail. Moreover, the schematic design is a useful guide in illustrating the proper placement and use for each product on air lines. It pinpoints the correct unit in the correct size at the correct location.

Color coding is also carried over into the index page. This page is striped with the key-section-color to the right hand edge. The color strip edge matches the exact color strip tab attached to respective section pages. The section



pages themselves are color keyed by both letters and numbers.

The various pages covering each Wilkerson unit contain complete line photographs, functional data, descriptions, explanation of operation, air flow diagrams, and specifications and information required for specifying. Two pages are devoted to technical information on compressed air. Included are charts on loss of air pressure, water vapor and flow rates. The catalog, Number 158, can be secured from distributors, the name and addresses of whom may be obtained from the company. *Wilkerson Corporation, 1645 W. Girard Avenue, Englewood, Colo.*

DIMENSIONAL air gauging is a vast subject; what may be the most comprehensive handbook on the subject has just been published. This 50-page book was written for inspection personnel, gauge designers, tool engineers and quality control personnel. It describes in clear, nontechnical terms, how to select the right amplification for the gauging job, when to use long-range air gauges, the advantages and principles of air gauging inside diameters, outside diameters and

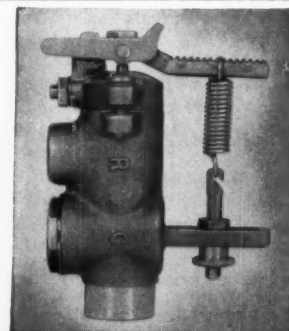
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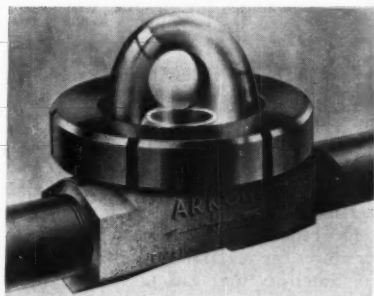


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other geometrical conditions, and many other facets of dimensional control. It also lists the large variety of standard adjustable and special tooling and gauging fixtures that are used with column-type instruments. *Sheffield Precisionaire Gauging* is available from The Sheffield Corporation when requested on company letterhead. Request must also include the writer's position or title, and the words "Publication No. SPG-160." The Sheffield Corporation, Box 893, Dayton 1, Ohio.

FOR FLOWS as slight as 0.075 gpm (water) and 0.5 cfm (air or gas), this simple reliable indicator shows flow at a glance. Clearly visible from a distance, even in poor light, is a ball dancing in the toughened glass dome. If the flow

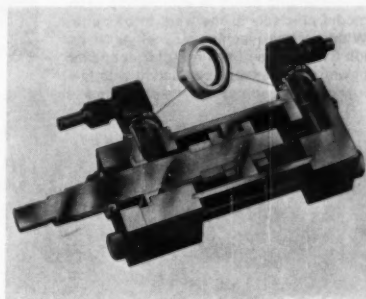


stops, the ball drops from sight. The indicator is useful in such applications as air, steam, water, and oil purge lines to instruments and mechanical seals; cooling water to compressors, condensers, jacketed process vessels, laboratory equipment, and electronic instruments; and lubricating oil to bearings. The Akron Ball-Type Flow Indicator, as it is called, is made with a die-cast bronze body in 1/2-inch pipe size for pressures to 100 psig. It contains either a nylon or a Teflon ball—the only moving part. *McIntosh Equipment Corporation*, Walker Crossweller Division, 15 Park Row, New York 38, N. Y.

A SOFT-SEAT needle valve—a product of Republic Manufacturing—for either gas or liquid that gives bubble-tight service to 6000 psig has an assured safety factor of 4, it is reported. All internal parts may be removed and serviced without taking the valve from the line. The sealing seat is nylon, protected from abrasion by a metal retainer. All metal parts are stainless steel, except the handle, which is aluminum alloy. Synthetic rubber O-ring seals are protected by Teflon back-up rings. The stem has 40-pitch thread for fine adjustment and ease of turning under high pressure, and is designed to prevent accidental removal. Port threadings are internal straight-gas-

ket seal in 1/4, 3/8, 1/2, and 3/4-inch O.D. sizes, and U. S. Bureau of Standards' high-pressure tube sizes 3/8- and 9/16-inch O.D. Operating temperatures range from minus 65° to plus 160° F., with higher available on special order. Bulletin No. 1059 describes these needle valves. *Republic Manufacturing Company*, 15655 Brookpark Road, Cleveland 35, Ohio.

PORT SEALS, that are reported to provide perfect sealing, speedy positioning, and complete protection from damage re-

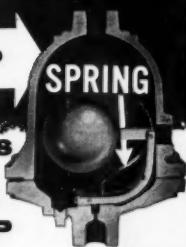


sulting from overtightening, are now furnished as standard equipment on all the regular models of air and hydraulic cylinders, booster, and accumulators manufactured by Miller Fluid Power Di-

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IN THIS AIR TRAP

NO COSTLY AIR LEAKS WITH THE ARMSTRONG SNAP-ACTION TRAP



The spring-powered valve snaps wide open for fast drainage, snaps tightly closed before all water leaves trap—always a perfect water seal. No dribbling, no air loss. Snap-closing prevents fine grit from holding the valve away from the seat.

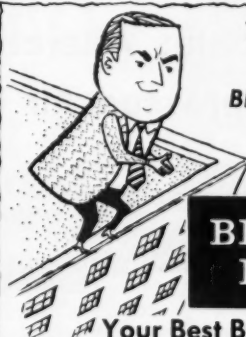
Trouble-free construction: the flat-strip spring of special Swedish steel lasts for years . . . valve and seat are hardened chrome steel. Cast semi-steel body for pressures to 250 lbs., forged steel for pressures to 1000 lbs.

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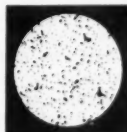
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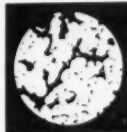
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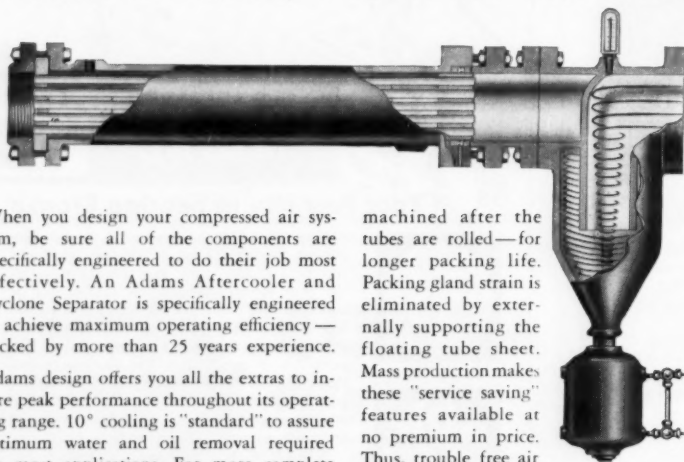
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When you design your compressed air system, be sure all of the components are specifically engineered to do their job most effectively. An Adams Aftercooler and Cyclone Separator is specifically engineered to achieve maximum operating efficiency—backed by more than 25 years experience.

Adams design offers you all the extras to insure peak performance throughout its operating range. 10° cooling is "standard" to assure optimum water and oil removal required for most applications. For more complete removal, 2° cooling is also available.

The exclusive Adams Cyclone Separator design assures you complete removal of the condensed liquid at any through-put up to design capacity, assuring you maximum separation for your cooling water dollar . . . and cleaner, drier air.

Many mechanical design extras are standard with Adams. The floating tube sheet is

machined after the tubes are rolled—for longer packing life. Packing gland strain is eliminated by externally supporting the floating tube sheet. Mass production makes these "service saving" features available at no premium in price. Thus, trouble free air is yours at minimum equipment cost.

Why not realize all the advantages of a unit specifically designed to do its job best. Write today for the complete story—ask for Bulletin 714.

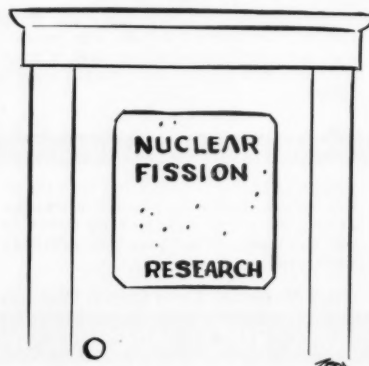
R. P. ADAMS CO., INC.

209 East Park Drive, Buffalo 17, New York

vision, Flick-Reedy Corporation. The seals consist of a hexagonal steel threaded nut with a threaded Teflon sealing insert that is impervious to the chemical or corrosive action of all hydraulic fluids, air, steam, water, gases, and practically all chemicals. To install, the seal is merely threaded hand-tight onto fitting or pipe. The fitting is then threaded into the cylinder port at least three turns, plus a fraction of a turn necessary to point the fitting in the desired direction. The installation is completed merely by tightening down the port seal against the cylinder port shoulder, using only light to medium wrench torque. The use of pipe dope compounds is completely eliminated. Company officials state that the port seal device has been tested and proved in field applications in many industries.

Miller Fluid Power Division, York and Thorndale roads, Bensenville, Ill.

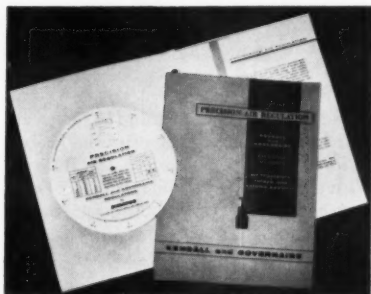
USED FILTER ELEMENTS can be restored to their original differential pressure and dirt-holding capacities by the Pall-Cavitron HIPS. The unit is a joint development of the Pall Corporation and Cavitron Equipment Corporation, and derives its designation from Hyperintense Proximal Scanning. This process produces the maximum ultrasonic cleaning intensity that can be created in a liquid. It places a hyperintense field over a small portion of the surface of the filter at one time. The filter element is rotated through this field until the entire surface of the element is cleaned. Particles are flushed away continuously as they are loosened. It takes less than 10 minutes to clean most filter elements to "like-new" condition, according to Pall spokesmen. The unit's basic ultrasonic generator and transducer are modifications of the same Cavitron system in use for many years for the ultrasonic machining of metals and ceramics. In addition, it contains bubble-point equipment to test the largest particles passed by the



cleaned filter, and equipment to measure pressure drop of a filter element. Both measurements are necessary to assure that the element is satisfactory for reuse. *Aircraft Porous Media*, a subsidiary of Pall Corporation, 30 Sea Cliff Avenue, Glen Cove, N. Y.

NICKEL MANGANESE "C" is a new hardfacing electrode developed by Airco. The composite 14-percent manganese electrode is suitable for smooth, economical build-up of railway manganese frogs and switches and for dipper teeth, bucket lips, crusher hammers, jaws and screens in the heavy construction industry, or where resistance to severe impact is desirable. The hardness as deposited ranges from 170 to 230 Brinell, and it will work-harden to 550 Brinell. The electrode meets AWS-ASTM classification EFeMn-A covered and can be used with either an a-c or d-c reverse polarity power source. Effective in all-position work, it is available, in standard 14-inch lengths in diameters of $1/8$, $5/32$, $3/16$, $1/4$ inch. *Air Reduction Company, Inc.* 150 E. Forty-Second Street, New York 17, N. Y.

ONE of the most handy and unique circular slide rules we have seen lately simplifies selection of pneumatic pressure regulators. It is incorporated in a new catalog of Gouvernaire and Kendall



regulators. The catalog gives performance and installation information for more than 25 pressure regulators, volume boosters and air relays. The Kendall regulators are direct acting; the Gouvernaire are pilot-operated. Both are designed for high precision. Special ones can be supplied for specific applications. *Fairchild Engine & Airplane Corporation*. Stratos Division, Industrial Products Branch, Route 109, West Babylon, Long Island, N. Y.

GAS WELDING and cutting hand torches, outfits, tips and accessories form the basis for Airco's revised 36-page catalog (Form ADC 702E). The company's group of equipment is discussed in detail with general descriptions, features,

REDUCE MAINTENANCE COSTS

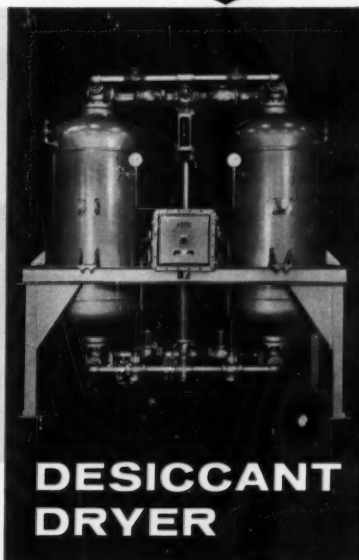
Moisture and oil in your air system will result in costly repairs, down time, and even system failure. Moisture causes rust that clogs delicate sensing devices, slows down pneumatic controls, and in some cases, brings about total destruction of expensive equipment. Random oil in an air system forms sludges, gums and hard varnishes, causing instrumentation and control breakdown.



Heat-Les

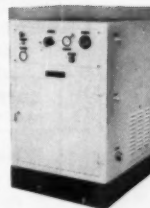
The Trinity Heat-Les dryer makes possible the driest air of all. This amazing dryer is being used in hundreds of industrial and military installations, and establishing new records for dependability, economy and performance.

- Dewpoints to -200°F .
- Low initial cost.
- No heaters to replace or power.
- No increase in air temperature.



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Heat-Les dryers are available in many sizes, for all pressures, from 1 scfm to 5000 scfm. Larger volumes may be handled through combinations of units. Also, in complete, unitized dry air systems, including compressor, accumulator and instrumentation



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Thermocouples and Thermowells

TRINITY EQUIPMENT CORPORATION, CORTLAND, NEW YORK

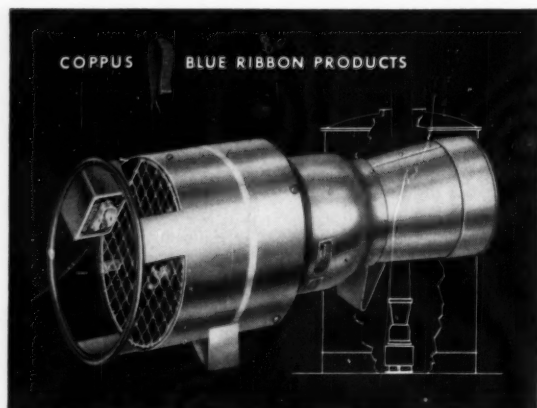
specifications and photographs given for each product. Included are specification charts on Airco welding and cutting tips listing all pertinent information that a user might need to make the proper selection for both general purpose and special gas welding and cutting. This revised edition contains information on many new products and improvements, including a general purpose welding torch with stainless steel head and fixed flow valves, two series of handcutting torches, four cutting attachments, Bernz-O-Matic Kits for utility flame heating applications, natural gas heating and brazing tips, and a wide variety of cutting and washing tips. *Air Reduction*

Sales Company, a division of Air Reduction Company, Inc., 150 E. Forty-Second Street, New York 17, N. Y.

ONE OF THE BEST of the so-called do-it-yourself booklets we have seen in a long time has just been published by the National Safety Council. It tells how anyone can lose a thumb or finger all by himself, using power tools, hand-operated equipment, or even without tools at all. Although the subject is grim, it has been treated in a humorous way with cartoons and color that make the publication quick and easy to understand, and, more important, to remem-

ber. It points out that fingers are Man's most important tools and that they should be taken care of. Single copies are available free of charge from the Council for inspection by interested safety-conscious industrialists. *National Safety Council*, 425 N. Michigan Avenue, Chicago 11, Ill.

URAMIC solenoid is the feature of a full-ported, direct-life solenoid valve with port sizes from 1/4 inch to 3 inches and capacities from 0-3000 psig. It assures reliable operation regardless of line pressures, according to company spokesmen. The 30,000 Series valve, as it is designated, was designed to meet the demand for positive operation over the entire pressure range. It is believed to be one



COPPUS "Blue Ribbon" Ventilator-Blowers are portable and easily adaptable . . . for supplying fresh air or discharging foul air or fumes. Mail coupon below for facts.

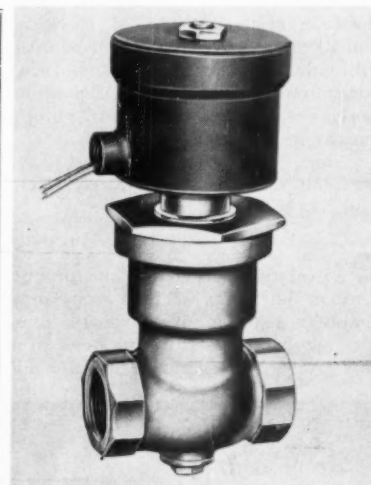
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| <input type="checkbox"/> on boiler repair jobs | City |
| <input type="checkbox"/> for general man cooling | |
| <input type="checkbox"/> to stir up stagnant air wherever men are working or material is drying | |



**COPPUS
BLOWERS**



of the most versatile solenoid valves available. For a complete description, specifications, and application data, Bulletin S-1 is available. *The Atomatic Valve Company, Inc.*, 545 W. Abbott, Indianapolis, Ind.

FULFLO, Delpark, Honan-Crane and Michiana filters for continuous microclarity of all types of industrial fluids—chemicals, gases, oils and water—are described in *Complete Filtration for Liquids and Gases*. The 8-page brochure gives information classified according to applications, operating pressures and sizes. In addition to the filters, various types of filter media are described and illustrated. Bulletin GEO-506A is available without charge. *Commercial Filtration Corporation*, Melrose, Mass.

CONVEYOR LUBRICATIONS of Fauber's 110 and 700 Series, are the subject of an 8-page brochure. It indicates three fundamental improvements in the design of the 110 Series automatic models: individual adjustment of wheel

nozzle and wheel manifold; redesigned trip-mechanism that actuates a Hunt Valve through a cam; and provisions that make it easy to put the lubricators in and take them out of service. Four improvements reported in the design of the 700 Series are: complete adjustability for the quantity of lubricant discharged into each wheel bearing; provision to vary air pressure in accordance with viscosity of lubricants; Universal Pick-Up (wheels of different manufacturers on the same conveyor chain can be handled equally well); and elimination of all drippage by the use of a nozzle with an automatic shut-off feature. *J. N. Fauver Company, Inc., 49 W. Hancock, Detroit 1, Mich.*

VERTICAL magnetic drives and heavy-duty synchronous motors are the subjects of two product leaflets (Nos. 4400-PRD-263 and 1100-PRD-252, respectively). The former describes drives designed expressly for pump applications. Vertically constructed, the machines are matched to fit standard vertical motors. The drives are air cooled. Speed variation is between 0 and 1740 rpm; the horsepower range is 3 to 310. An automatic speed control circuit is part of the drive package. The other brochure describes the E-M line of bracket-bearing synchronous motors. These are rated at 60 hp and up, at speeds from 500 to 1800 rpm. Suitable for standard voltage connection, the motors are built in a variety of enclosures for various requirements. *Electric Machinery Manufacturing Company, Minneapolis 13, Minn.*

POROUS stainless steel filters are described in 4-page bulletin M-212A. Included are information on properties about porous stainless steel, full speci-

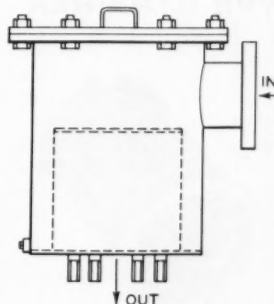
fications of standard filters manufactured by Pall Corporation, and a number of new filter types and sizes. Special features of the brochure are photographs and descriptions of many custom-designed filters and filter elements. Detailed technical data are also given to permit direct ordering of stock units. *Pall Corporation, Micro Metallic Division, 30 Sea Cliff Avenue, Glen Cove, N. Y.*

AN INTEGRAL dust collector with no filter to change is reported to be capable of handling high concentrations of dust over a wide range of particle sizes, by

using 2-inch-diameter tubes. The tubes are of a new design, installed in multiples until the required capacity is reached. Developed to remove dust in grinding, buffing, polishing, milling and cutting operations, the unit is said to provide high collection efficiency, constant suction at hood and no fire hazard. Dust-laden air entering its inlet passes first through a primary cyclone for removal of large heavy particles that are deposited in the primary bin (see illustration). The air then travels through a secondary collector comprising tubes of the new design. Here final cleaning takes place before the air passes through the fan and on to the outlet. A signif-

IN-THE-LINE FILTERS

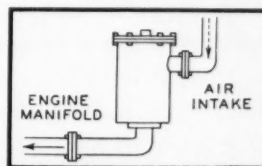
dry-type, oil-wetted and oil bath types



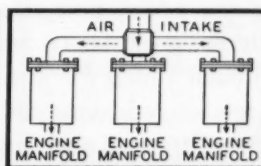
A line of filters for "in-the-line" or "closed circuit" operation is manufactured by The Air-Maze Corporation. Built for efficient filtration of air and gases, these filters are incorporated on remote air intake lines for engines, compressors or industrial heating furnaces. They are used for the filtration of fuel gas to engines; and for filtration of natural gas on transmission or gas processing applications. Cleanable, dry-type units are available for

extremely fine filtration, where dust loads are low or where oil must be absent from the gas stream. Oil-wetted and oil bath types available where dirt loads are higher and where continuous low pressure drops are mandatory.

Write for bulletins. The Air-Maze Corporation, Dept. OG-10, Cleveland 28, Ohio. (Subsidiary of ROCKWELL-STANDARD Corporation)



Intake line for air compressor

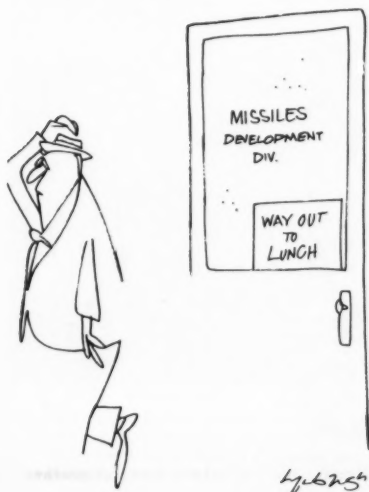


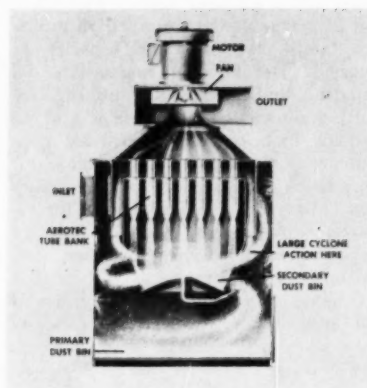
Intake systems for multi-unit compressor station

AIR-MAZE

The Filter Engineers

AIR FILTERS • SILENCERS • SPARK ARRESTERS • LIQUID FILTERS
OIL SEPARATORS • GREASE FILTERS



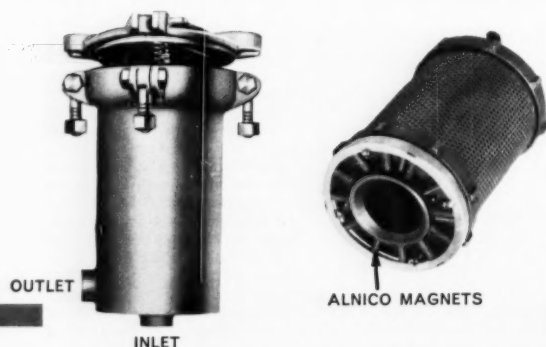


cant feature of this dust collector is its no-pressure-build-up characteristic. As a result, dust is continuously removed from the path of flow and discharges downward to a secondary receiver that requires infrequent attention. The collector is available in seven standard sizes ranging from 300- to 2100-cfm capacity. The manufacturer also builds special assemblies ranging from a single tube of 30 cfm to capacities of 50,000 cfm and larger. *Aerotec Industries, Inc., Industrial Division, Greenwich, Conn.*

FACTS concerning the use of shot and

grit abrasives in blast cleaning, are detailed in a 30-page booklet. It is divided into five sections: (1) an appraisal of blast cleaning functions and materials, including common fallacies, considerations of shot and grit size, consumption, maintenance costs, and time and finish factors; (2) a compilation of progress and research achievements, including new products, materials, specifications and the like; (3) the effect of housekeeping on the use and performance of shot and grit; (4) chart-illustrated methods of computing costs of new abrasive products against existing or former materials; and (5), a suggested method for cost-free investigation of substantial blast cleaning savings. Copies are available without charge. *National Metal Abrasive Company, 3560 Norton Road, Cleveland 11, Ohio.*

GET THE ADDED PROTECTION OF MAGNETIC SEPARATION WITH THIS BASKET-TYPE STRAINER



Nugent now manufactures a line of basket-type strainers offering the added protection of magnetic separation. Specially designed Alnico magnets establish a magnetic field through which the strained liquid must pass as a final stage before leaving the unit. Thus, minute ferrous particles are trapped and removed from the fluid stream.

If you have valuable engines or other equipment which demands top-notch lubrication protection, it will pay you to get the full story on the Nugent combination strainer-magnetic separator.

Write today . . . no obligation, of course.



WM. W. NUGENT & CO., INC.

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OIL FILTERS • STRAINERS • TELESCOPIC OILERS
OILING AND FILTERING SYSTEMS • OILING DEVICES
SIGHT FEED VALVES • FLOW INDICATORS

CONTROLLING small cylinders or operating diaphragms are two of the jobs for Trim Line valves. Complete specifications and performance information about the valves are given in a 12-page catalog (No. 592). Six valve actions are available; illustrations of these actions are given. Included too are dimensional drawings and complete descriptions and specifications. *Hunt Valve Company, Salem, Ohio.*

ZIRCONIUM, a prominent construction material in atomic reactors, has many applications in other industries too. In view of this, The Zirconium Association has published a *Fact File* that contains technical data, application information, available forms, and sources of supply of this unique metal. The publication's material was compiled by manufacturers and fabricators of the



Schaffy

"Looks like another bum shipment."

metal, and will be useful to executives and technical and research personnel in chemical processing, electronics, automotive, aircraft, missiles and other fields. It is available without charge when requested on company letterhead. *The Zirconium Association*, 2130 Keith Building, Cleveland 15, Ohio.

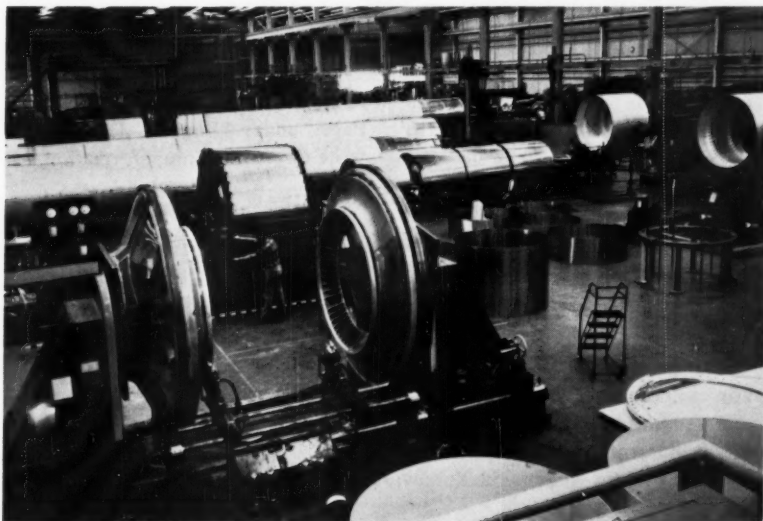
CORROSION Resistance Chart J-CRC is available from OPW-Jordan. It lists more than 150 chemicals and their recommended usage with ductile iron, iron, steel, 316 and 304 stainless steel, monel, brass, bronze, copper, aluminum and plastisol plastic. J-CRC also shows which gasket materials are needed for the various chemicals when Kamlok Quick Couplers are used and which O-ring materials are needed when swivel joints are used with these chemicals and compounds. The 4-page chart is available without charge. *OPW-Jordan*, 6013 Wiehe Road, Cincinnati 13, Ohio.

TRUCK CRANES of American Hoist's 200 Series, rated at 22½ tons, are discussed in a 20-page catalog that has a profusion of on-the-job photographs as well as other illustrations and descriptions of the exclusive time-saving features and versatility of these units. The catalog is designated No. 732-TG-2. *American Hoist & Derrick Company*, St. Paul, Minn.

REGULATING relief valves, named Atlas No. 280 Type G, that govern the discharge pressure of constant-speed pumps in oil or water service are described in a recently published 2-page catalog sheet. They can be used at initial pressures to 500 psig and temperatures to 250° F, and will relieve at adjustable pressure ranges of 20-70, 50-175, 150-250 and 350-500 psig. The bulletin includes operation and installation information as well as valve photographs, drawings, and a chart showing the rate of oil or water flow through the valve. *Atlas Valve Company* 280 South Street, Newark 5, N. J.

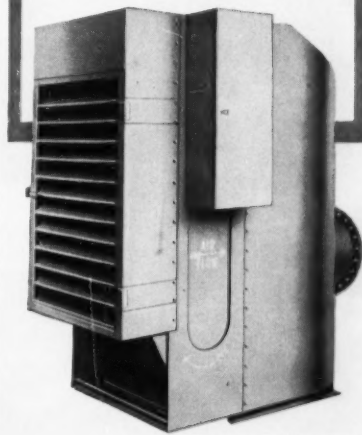
AIR BRAKE tanks made of fiber glass for the motor transportation industry are discussed in *Apex Fibre-Glass Air Brake Tanks*. The folder describes the advantages and engineering applications of the newly developed line. According to the brochure, advantages include: weight reduction of as much as 66 percent; elimination of tank corrosion and maintenance; greatly increased safety; and elimination of compression noise. Charts provide a means for exactly calculating the required lengths, weights and volumes. The brakes are offered in diameters of 7 and 9½ inches. *Apex Reinforced Plastics*, White Sewing Machine Corporation, Washington and Elm streets, Cleveland 15, Ohio.

SPACE VEHICLES TO BE



A massive rocket engine that may make possible manned flights to the moon and electronic exploration of planets is being assembled at Huntsville, Ala., by the Army Ballistic Missile Agency. Tanks for the superbooster, of sheet aluminum supplied by Alcoa, are shown here in various stages of fabrication. Designed for Saturn, the nation's first interplanetary space vehicle, the engine is rated at 1,500,000 pounds thrust.

AAF Multi-Duty Filters Assure Clean Intake Air Automatically



Type CMS Multi-Duty for air volumes of 3000 CFM and up.

When your engines and compressors are protected by AAF Multi-Duty Self-Cleaning Filters, you *know* that intake air is *clean*.

Uniform air delivery, constant efficiency, low operating resistance and infrequent maintenance are "musts" for true dust protection. Multi-Duty measures up on every count because this filter keeps itself "fit" through continuous self-cleaning action.

Would you like more information? Write today for our 16 page illustrated catalog.



American Air Filter
COMPANY, INC.

402 Central Avenue, Louisville 8, Kentucky
American Air Filter of Canada, Ltd., Montreal, P. Q.

GET REAL PRODUCTIVITY—GET A GM DIESEL



That's the way John Curran, president of Michigan's Dearborn Excavating Company-Downriver Crane Company describes the job his "Jimmy" Diesels are doing for his companies.

He's got a 3-71 GM Diesel in an IR 315 Gyro-Flo, a 4-53 "Jimmy" in a 250 Gyro-Flo, a 4-71 in an American 395 crane and a 3-71 in a Lorain TL-25 crane.

How are his "Jimmys" working? Listen to John Curran: "GM Diesel-

powered equipment has earned us more profit because we've had few parts to replace and very few service repairs. Having to replace only a fuel pump on our first GM Diesel during four years of heavy going in sewer work is reason enough why we're behind Diesel power for all equipment large enough to take a Diesel."

You can get that kind of service from your equipment with a GM Diesel in your equipment. Proof? See your GM Diesel distributor—he's in the Yellow

Pages under "Engines, Diesel"—or write direct for more information.



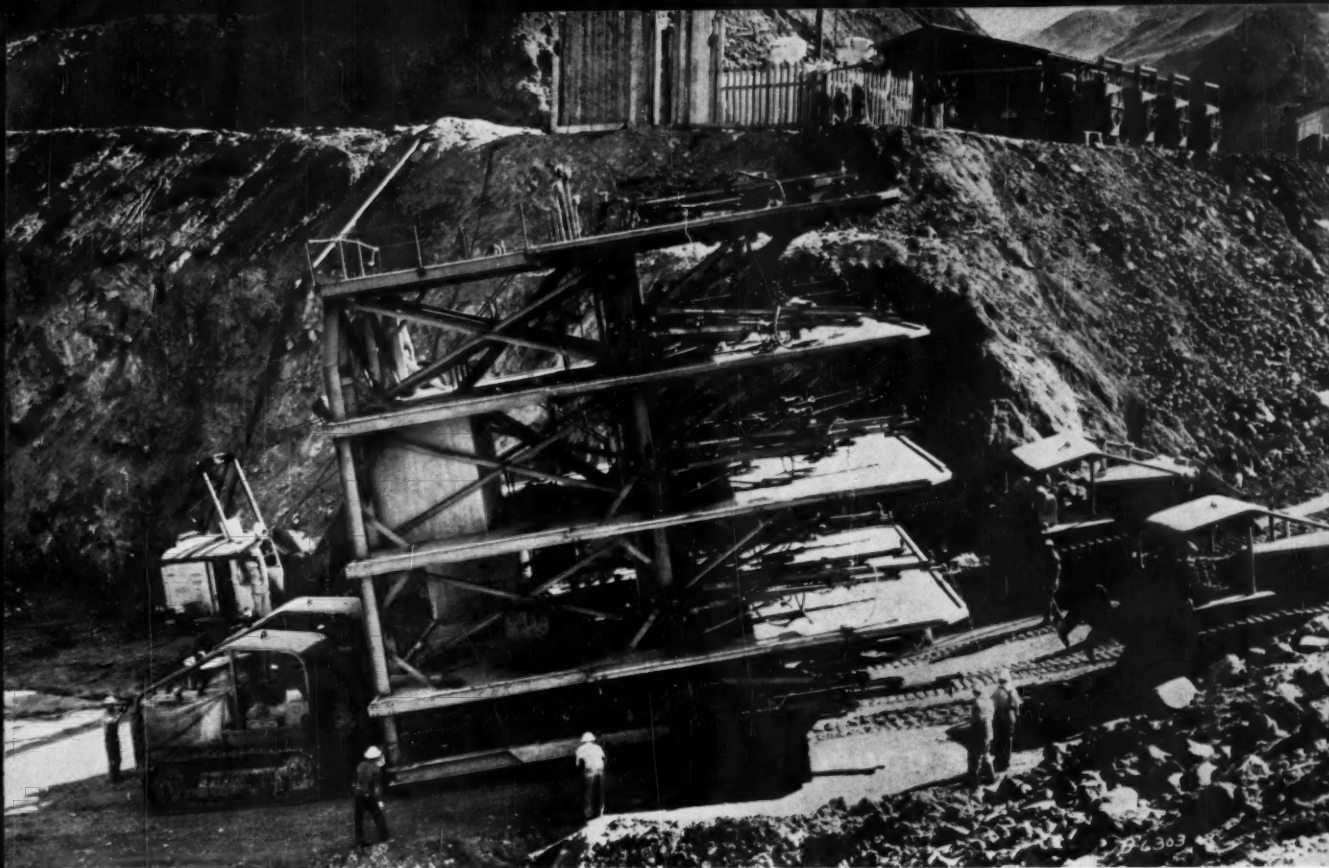
GM DIESEL

DETROIT DIESEL ENGINE DIVISION,
GENERAL MOTORS, DETROIT 28, MICH.

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GM DIESEL ALL-PURPOSE POWER LINE

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World's biggest Hydra-Boom jumbo drives **OXBOW TUNNELS**

*19 Hydra-Boom mounted I-R drifters
on five-level air-driven jumbo,
drill twin 42-ft bores for
200,000 kw hydro station*

Shown above being moved up to the working area with an assist from four tractors, is the largest tunnel jumbo ever built—taller than a four story building and carrying the concentrated “fire power” of 19 Ingersoll-Rand D-45 drifters on 10-ft chain feeds with I-R Hydra-Boom mountings. Designed and built by Morrison-Knudsen Company, Inc., this huge jumbo was used to drive the twin 42-ft horseshoe power tunnels that will supply Idaho Power Company's 200,000-kw hydro-electric station on the Oxbow bend of the Snake River.

The Hydra-Boom mountings permit rapid hydraulic positioning of all drills from convenient central-

ized controls at each drilling station. Drilling 2½” holes 10 ft deep with modified Vee pattern in the hard, chunky columnar basalt of the area, the jumbo was moved alternately from one bore to the other—drilling in one while the other was blasted and mucked. The crawler-mounted jumbo is self-propelled in the working area by 25-hp I-R air motors.

Air power for the tunnel jumbo was supplied by a bank of six skid-mounted I-R electric-driven XLE compressors with a total capacity of about 8000 cfm at 100 psig—shown at upper right in the photo above.

Whenever you want fast, effortless drill positioning on any job, be sure to check the advantages of I-R Hydra-Boom mountings. Your Ingersoll-Rand engineer will be glad to give you complete information.

Ingersoll-Rand
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A CONSTANT STANDARD OF QUALITY IN EVERYTHING YOU NEED FOR DRILLING ROCK.

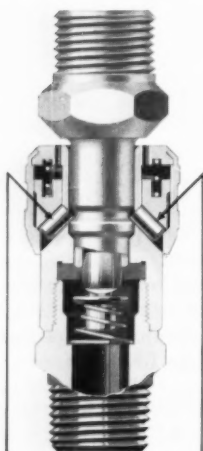


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BY YEARS OF HARD
EVERYDAY USE IN
THOUSANDS OF PLANTS



Wherever you have fluid line connections...



Tamper-Proof Socket
Head—with leak-
proof, minimum
wear, locking device.

—AS EASY AS PLUGGING IN
YOUR ELECTRIC SHAVER



- Quick connection and disconnection—as easy as plugging in your electric shaver.
- Instant automatic flow or shut-off.
- Factory assembled socket head cannot be readily damaged—or have component parts lost by casual tampering.
- Locking pins afford large area contact with Plug—reduces wear to a minimum.



Write for the Hansen Catalog

Here is an always ready reference when you want information on couplings in a hurry. Lists complete range of sizes and types of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings.



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FROM FORGING TO FINISHED PRODUCT

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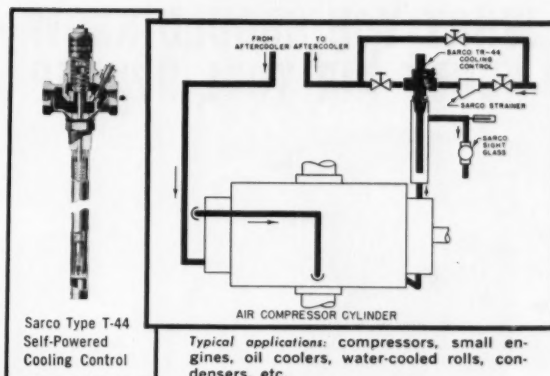
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Sarco Type T-44
Self-Powered
Cooling Control

Typical applications: compressors, small engines, oil coolers, water-cooled rolls, condensers, etc.

PROTECT COMPRESSORS against undercooling and overcooling

Undercooling cuts down compressor capacity . . . often damages cylinders, other parts.

Overcooling increases wear, destroys lubricants, wastes water.

You can avoid these troubles, step up the performance of your compressors, reduce maintenance, save water and lubricants. How? By replacing uncertain manual control of cooling water . . . by *automatic*

control with Sarco self-powered temperature regulators.

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Inexpensive. Simple. Require no outside power source. Packless. Easy to install by any pipefitter.

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WHAT YOU SHOULD KNOW ABOUT AIR TOOL UPKEEP



Ordinary oil
Separates from
water

NON-FLUID OIL
TRADE MARK REGISTERED

emulsifies with water

The NR grades of NON-FLUID OIL work on the principle "if you can't lick moisture, join it." They emulsify permanently with air-borne moisture . . . go right along with it and protect working surfaces from rust and corrosion, sticking and gumming. Result: your air tools deliver top power and operating efficiency.

That's why pneumatic tool manufacturers use and recommend the NR grades of NON-FLUID OIL for their equipment, and why the NR grades are employed by hundreds of major air tool users. Write for free testing sample and Bulletin No. 550. See for yourself.

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NON-FLUID OIL is not the name of a general class of lubricants, but is a specific product of our manufacture. So called grease imitations of NON-FLUID OIL often prove dangerous and costly to use.

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WIDE RANGE AIR METER



Model DO-150

FOR TOP PRODUCTION EFFICIENCY AND HIGHEST AIR ECONOMY

Simple Operation

Rugged Construction

Accuracy to $\pm 1\%$

Tele.

Plainfield 6-8010

This all new meter permits the accurate measuring of air-flows from 10 to 150 CFM in 2 CFM increments and is designed for operation with 2" pipe lines, stands 19" high and weighs approximately 31 lbs. It is constructed of gray cast iron and brass for long years of dependable service. Operation is designed for 80 psi, however conversion factors permit volumetric readings to be taken at pressures ranging from 2 psi to 300 psi. Accuracy of the DO-150 is $\pm 1\%$.

Four other air meters permit complete coverage of air flow measurements from 4-450 CFM. They are: TO 4-40, TO 10-100, DO 50-300 and DO 125-450.

For the economical repair of any air operated device or the solution to an air flow problem, contact:

NEW JERSEY METER CO., INC.

350 Leland Avenue • Plainfield, New Jersey

NEW T TYPE SEPARATOR IMPROVED CYCLONE DESIGN

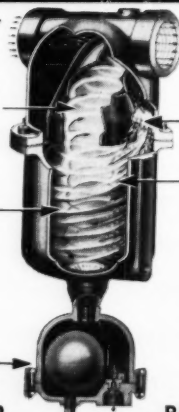
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ENTRAINMENT SEPARATION**

IN-LINE
INSTALLATION

LARGE, HI LEVEL
OUTLET CHAMBER
NO
REENTRAINMENT
PROBLEM

ENTRAINMENT
HUGS WALL
FLOWS TO
BOTTOM DRAIN

AUTOMATIC
DRAINAGE WITH
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FLOAT OR
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SCREWED OR
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HI SPEED ENTRY—
MAX. CENTRIFUGAL
ACTION

CLEAN DESIGN
PRODUCES MIN.
PRESSURE LOSS

AVAILABLE IN
SIZES TO 8"
PRESSURES
TO 1,000 P.S.I.

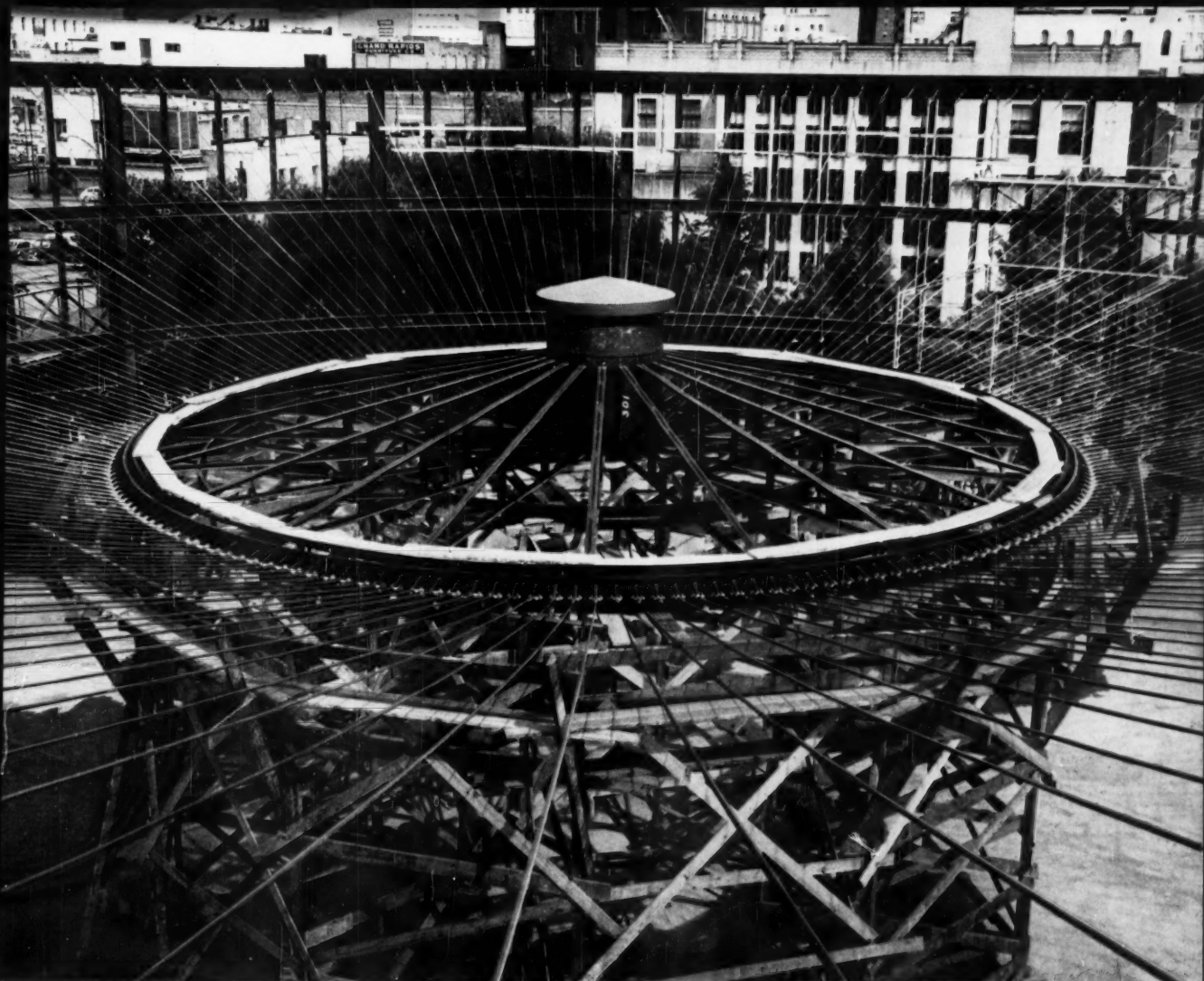
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General Contractor: G. W. Mitchell; Architects: O'Neil, Ford and Associates, Nicanor Salas, project architect; Structural Engineer: W. E. Simpson Company; Steel Fabricator: Alamo Iron Works

Saucer-shaped roof in San Antonio supported by 200 Bethlehem Strand assemblies

Some Texans call it the Roundhouse . . . others refer to it as the Sombrero. It's the new Villita Assembly Building of the Public Service Board of San Antonio, and it's believed to be the only building of its kind in the United States. The circular structure will help promote San Antonio as a convention site.

The roof is supported by 200 Bethlehem bethanized strand assemblies. The assemblies consist of pre-stretched strands with swaged fittings, and turnbuckles. The pre-stretching limited the resid-

ual constructional stretch, and also raised the modulus of elasticity.

Bethlehem Strand is ideal for suspended-roofs, and other construction, because it provides maximum strength per unit of weight and diameter. Moreover, the bethanized coating of electrolytic zinc comes in three coating weights, for long-lasting protection against corrosion.

For full details about Bethlehem Strand, get in touch with the nearest Bethlehem sales office, or drop a line to us at Bethlehem, Pa.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

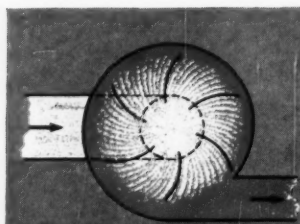
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Mill depots and distributors from coast to coast stock Bethlehem wire rope



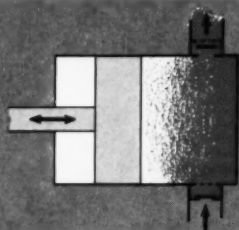
TAKE ANY GAS...

WHIRL IT



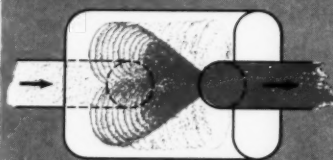
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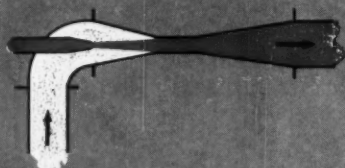
with a Reciprocating Compressor

SQUEEZE IT



*with an Axial-Flo
Rotary Compressor*

PULL IT



with an Ejector

**...but only ONE METHOD IS BEST for a given job
and only Ingersoll-Rand offers ALL FOUR!**

For any pressure, or gas, Ingersoll-Rand can supply whatever type of compression or evacuation system will meet your exact requirements to *best advantage*—with maximum efficiency and dependability. For completely unbiased recommendations that will save you money in the long run, be sure to call in your Ingersoll-Rand engineer the next time you have a compression problem.



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